AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

SEPTEMBER, 1898.

CONTENTS.

A CHAPTER IN METROLOGY.

By Edward Grafstrom.

Spasmodic efforts to revolutionize the country's system of weights and measures by substituting the metric standards for the English, have been made from time to time, and will undoubtedly be repeated until eventually the goal is reached. That these efforts so far have been unsuccessful is due to defective methods employed by the advocates of the metric system to gain their ends, or perhaps to their lack of method and disregard for local conditions.

That the day will come when there will be a universal system for measuring the products and commerce of nations, is in the destiny of the world, and what this system is to be is told by the 500 millions who to-day are using the meter, a modern production, while the Anglo-Saxon race is still in sole possession of that remnant of a past civilization, the ancient yardstick.

Although it originally was a feeling of insular conceit which made England decline the invitation to be present at the birth of the meter a century ago, the advantages of the metric system are now generally admitted by every Englishman and American who has given the subject an unprejudiced study. For him it has simply become a question whether these advantages are worth the cost and trouble which it would take to transfer the immense commercial and industrial system of these countries from one standard to another.

But the masses do not look upon the subject in the same light. They are contented with what they have, because they have never felt the need of anything better. The new names are "Greek" to them, and even the decimal system looks suspiciously meaningless. The British are peculiarly tenacious of old customs, as are Americans of what they regard their personal rights. No Parliament or Congress would care to show its strong hand and use its constitutional right to take the decisive step in the face of such opposition by the majority of the voters. Compulsory adoption of the metric system in this country, as in England, depends upon the people, and there will be no public demand for it as long as its value is beyond the comprehension of the masses.

The question may be asked: Why is it, then, that the introduction of the metric system has been so thoroughly successful in other countries? It is certainly not that the Anglo-Saxon mind is more dull or less susceptible to new ideas. On the contrary, it is, perhaps, the characteristic energy of the race which has been one of the barriers to the new system: to do the work of a lifetime in a couple of years.

The answer to the above question will, instead, be found in the history of each nation, in the political events of the time at which the change was made. In the restless period following upon the revolution and the advent of Napoleon, the volatile minds of the French people were ready for anything which would assist in overthrowing the old conditions. New social habits, new governments, succeeded one another. The map of Europe was remodeled. New coinage was introduced, and even the reckoning of time was meddled with. What could be more natural than that the new system of weights and measures should meet with favor? But in spite of Napoleon's edicts and the revolutionary spirit of the time, it took France 40 years to settle down to the undisputed use of the meter.

In Germany the change came with the new empire. A common unit was needed to promote interstate traffic and trade between the many principalities constituting new Germany, and for that purpose the victors brought home the meter from vanquished Paris at the end of the Franco-German war.

The history of many other metric countries also shows that the time of change was not arbitrarily chosen, but was connected with other important events. The public was prepared for the change either by circumstances or by a paternal and far reaching government. In countries previously possessing well developed systems of weights and measures, the transitional period was of sufficient length to avoid unnecessary hardships and expenditures.

The writer has had the fortune, or perhaps the misfortune, to live successively in two countries during such periods of transition, and for the purpose of illustration it may be interesting to relate the developments connected with the evolution. The time allotted for the purpose was in one case 10, in the other 8 years. Each one of these countries was up to that time following a system of foot and pound but slightly varying from the English standards.

The first indication of the advent of a new system came from the schools, the educational branch being under full government control. In the primary schools the children were taught the metric system before the intricacies of the old system were explained, and in the higher grades and colleges mathematical examples were worked on the metric basis. Within a year enterprising publishers put on the market metric editions of mathematical and other text books affected by the change. The new idea took root at once and throve in the fresh minds of the pupils, and later when these thousands of adherents to the new system were turned out in the world, year by year, the popularity of the system was assured. But the great mass of people, who were already beyond the reach of the school, had to be converted in the meantime.

The next step was in the form of an object lesson. On all the government railroads the distances were remeasured and kilometer posts put up in addition to the old mile posts. On station buildings the distances in kilometers were added. In the country districts such public highways as had old mile posts were next supplied with new ones, leaving the old ones undisturbed. These steps gave the traveling public, the railway men, the farmers, opportunities for comparison and reflection.

About this time new foot rules, weights and scale balances, graduated on both systems, also began to appear, and advertisements in the form of calculated converting tables and mechanical converters were freely distributed. People began to be educated up to the point of change.

The following year all applicants for position in the civil service were required to be thoroughly familiar with the metric system, and private employers soon followed lead. The system began to be tested. People bought silk and ribbons by the meter in the dry goods stores, coffee and tea by the kilogram in the grocery, and called for a liter of beer at the restaurant. It soon became a fad. You were not up to date if you didn't handle the meter system with perfect familiarity. Four years had passed, not a single compulsory step had been taken to inconvenience the public, and yet from all outward signs the country was on a meter basis.

The next step was to put the postal, railway and custom tariffs on the same plane. When they were introduced there was no confusion or interruption; they fitted right in with the situation, and everybody understood them and was expecting them.

So far no change had apparently been made in the manufacturing industries. Dimensions of new machines and tools began to be evened up to avoid fractional milimeters wherever possible. Screw taps and reamers were named after their nearest metric size, but master gauges and test blocks were not, as a rule, interfered with. The rolling mills altered their rolls imperceptibly as new ones were needed. There was no abruptness, no interruption, and the extra expenditure was compensated for by the time saved in making calculations and estimates, or in keeping shop and material accounts.

Before the period of transition had expired the metric system had infused trade and commerce, and become part of the national life. But the evolution had taken place under the guiding hand of a centralized government, which controls schools, railroads and telegraphs, and exerts a subtle influence over all other public institutions.

In the United States the conditions are so vastly different and the undertaking of such magnitude, that the problem could not be treated in the same manner. It is doubtful

whether the national government could do much more than it already has done. In 1866 an act of Congress authorized the use of the metric system. The two standard meters, Nos. 21 and 27, and the two standard kilograms, Nos. 4 and 20, which President Harrison officially received in 1890, are the prototypes of the only measures and weights made lawful in the United States. The treasury department has so recognized them, by defining the yard and the pound as certain parts of the standard meter and kilogram. In 1893 Congress adopted a standard metric sheet metal gauge, which has since been used exclusively for fixing duties and taxes levied by the United States.

What more can be done by a government which is depending on a majority of the people for its existence? It has legalized the use of the meter and adopted it for its own need, as far as it is possible without interfering with the commerce of the country. For those that want to use the system it is there, and pharmacists, electricians and some other classes have availed themselves of it for professional use. But the vast multitude do not at present ask for it, and Congress does not legislate except in accordance with the wishes of the majority.

Until public opinion is favorable to the change it is, therefore, impossible to see how any practical advance can be made for the metric system. Some great event of national importance may occur, either in this country or in England, which may throw another light upon the subject, and if it should cause either one of these two great nations to feel that the time had arrived for making the change, the other would soon follow.

American export trade is certain to be extended as a direct result of the present war, no matter what the foreign policy of the country will be. That the future relations with Spain's former colonies would not necessarily have any influence on the weights and measures of this country is shown by a statement made last year before the British Institution of Civil Engineers, that England's trade with her colonies and with the United States is only 10 per cent. of her total foreign commerce, the other 90 per cent. being principally with metric countries. In the same manner this country will develop its trade in the new markets in proportion to its advantages in location and facilities, regardless of the metric system, but in the face of the strong competition with English, French and German producers the adoption of that system would greatly assist American exporters. The manufacturers in England, who have adopted the metric system, have done it for similar, purely commercial, reasons.

It is not for the exporters or shippers to revise the country's system of weights and measures, however, except as far as concerns their own use. Nor is it for the railroads to base their rates and tariffs on units unfamiliar to their customers. It is a matter for the whole population to decide, and as long as the majority of the voters do not see how they could gain anything by the change, they will have none of it.

It remains, then, for the believers in the metric system to work for a reversal of the majority's opinion, to create a favorable sentiment for the new measure among the masses. It is not the object of this article to point out how this may be done, but suffice it to say, that here, as in other countries, the school is the first place where the seed should be sown. True, the schools have for years taught the metric system, but not for practical use, not on the same level as the English, but more as a sort of a side issue, a curiosity, which has been forgotten as soon as the school door closed behind the pupil.

In England there is a steadily growing society for the promotion of the metric system, and the suggestion is made that such an institution in this country might possibly bring together the friends of the system in all walks of life, in the educational branches, in railroads, manufacturing and commerce. By concerted action such a society might succeed to take one step after another, and to gradually lead the masses up to the point where legislative action could be taken without opposition.

[The attention of our readers is directed to the fact that the American Metrological Society was organized in 1873 for the purpose suggested by Mr. Grafstrom. Its present officers are: President, Prof. T. C. Mendenhall, who is President of the Worcester Polytechnic Institute and was formerly Superintendent of Standard Weights and Measures of the United States Government; Secretary and Treasurer, Prof. J. H. Gore, Columbian University, Washington, D. C. We also direct attention to the communication by Prof. T. C. Mendenhall on another page of this issue. It should be stated that the American Railway Association has considered the subject of the metric system and will take it up in the form of a committee report at the next convention.—Editor.]

THE FUTURE DEVELOPMENT OF THE LOCOMOTIVE.*

By Maurice Demoulin, Engineer.

The locomotive is at present in most countries undergoing an interesting evolution, tending to make it a more suitable instrument for hauling increasingly heavy loads at higher and higher speeds; in other words, to increase its actual power, its power per unit of weight and its stability. The limitations due to the strength of the road and bridges or to the gage and clearance, to the minimum permissible radius of curves, to the length of turntables and to other special circumstances combine to render the problem more difficult every day. But up till now the locomotive has fulfilled all requirements and has developed in proportion to the traffic. And if we were tempted to believe that it had almost attained the extreme limit and that its further development was stopped by the restricting circumstances with which it is surrounded, we need only cast a glance at what is happening on the other side of the Atlantic, and we shall be convinced that the limitations are of a very elastic nature, and that they can be considerably stretched. We find, moreover, especially in France, Belgium and Austria, tendencies similar to those which have lately led to such remarkable changes in American engines. It is therefore not without interest to see, in a general way, what these tendencies now are and to what types of locomotives they may lead, types which will besides vary less and less according as, in the future development of the locomotive, the dimensions of its principal parts reach determined limits. In short, the variety of types ought to decrease as the difficulties met with in the arrangement of their parts increase. For instance, when in 4-coupled engines the dimensions of the fire-box grow to a given extent, there remains only one, or at most two, methods of arranging the fire-box relatively to the wheels; similarly when the diameter of the cylinders exceeds a certain limit, they cannot be placed inside the frame plates, and consequently the inside cylinder arrangement, at present much in use, must disappear.

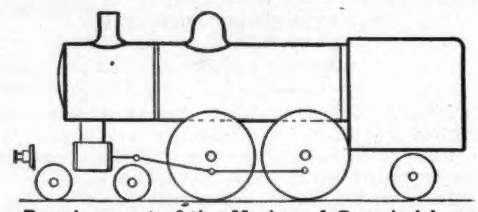


Fig. 1.—Development of the Modern 4-Coupled Locomotive.

It is necessary to differentiate between increases of absolute power and increases per unit of weight. If the absolute power only of a locomotive be increased, its weight becoming proportionately greater, heavier loads could, it is true, be hauled at given speed, but the maximum speed possible would not be greater, for this could only be attained by increasing the power per unit of weight.

I mean here by power the work which a locomotive can do, and not merely, as is sometimes meant in railway parlance, the capacity an engine possesses of hauling a load; in other words, I am considering the power developed on the pistons, or at the rim of the wheels, or at the draw bar, and not exclusively the amount of tractive effort, more or less apart from all idea of speed.

The increased power per unit of weight may be attained by the reduction of dead weight without the total power of the motor being altered.

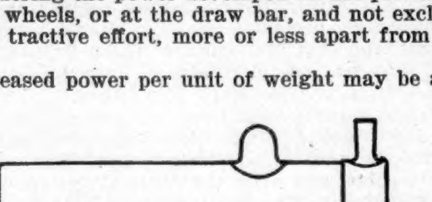


Fig. 2.—Development of Modern 6-Coupled Locomotive.

An increase of the absolute power and in the power per unit of weight at the same time may be attained by greater economy (in consequence of a better utilization of the heat produced) and by increased steam production in the boiler.

An increase of the absolute power alone can be effected by increased capacity of the boiler and cylinders.

Improvements in the quality of metal used can only be regarded as a means capable of increasing, quite indirectly, one

*From a paper in the Bulletin of the International Railway Congress.

of the two above-mentioned powers, and then only in consequence of the greater economy thus obtained. Engines can in this way be made more flexible and be made capable of containing in their boilers a greater quantity of potential energy.

We will now discuss, as briefly as possible, how and to what extent engines can under present conditions be made more powerful and less heavy.

Increase in an engine's absolute power depends upon the boiler. It is easy enough to increase the cylinders as much as one likes and construct the other moving parts in proportion, but to increase the power of boilers is far from being so easily managed, although we are, at least in Europe, far from having attained the extreme possibilities which, owing to the increasingly general tendency to raise boilers, have been extended far beyond the limits that it formerly seemed reasonable to expect.

When the fire-box comes down between the frame plates its outside measurement must be a little less than the distance between the frame plates, or about 4 feet 7-16 inch, and this must be further reduced by some 1¼ or 1⅝ inches if the fire-box is to be situated between the horn plates of one of the axles. If the frame plates are outside the wheels, a practice once very common in Europe and still usual on the Belgian state railroads, the width of the fire-box is no longer limited, but by external measurement may be easily made about 4 feet 1¼ inches. Besides, the axle boxes and their slides, which are outside, no longer interfere, and this permits of the fire-box ring being put nearer the axle beneath it, and, as the height of barrel remains the same, the fire-box can be made deeper.

But, as the fire grate cannot be made indefinitely longer—the maximum length being limited, through its being necessary to allow of free enough action of the fire, to about 9 feet 2¼ inches, though as much as 10 feet 2 inches has been tried —it is impossible, when the fire-box reaches between the frame plates, or only between the wheels, to make the grate area appreciably more than 32 square feet. A grate surface such as this is obviously sufficient with ordinary fuel to develop enough power to haul the heaviest and fastest trains at present run, but it would not be enough to do the work if less good or very small coal, or coal such as anthracite, were used. It will not suffice as soon (and the day may soon come as it becomes necessary to run heavier and faster trains and to go up gradients at higher speeds. The necessary power will be deficient, inasmuch as the rapidity of combustion can-

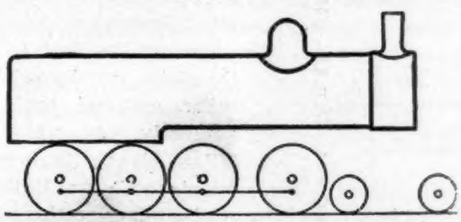


Fig. 3.—Development of the Modern 8-Coupled Locomotive.

not be proportionately as great on large grate surfaces as on small ones. Three times as much fuel will not be consumed on a grate with an area of 32 square feet as on a grate with an area of 11 square feet. The way in which the fire is kept up and the method in which locomotive fire-boxes are arranged, the quality of the fuel remaining constant, tend to reduce the quantity of coal that can be burned per unit of time and per unit of grate area if this be increased. As soon as the grate area exceeds a certain figure we must expect to find a reduction in the power it is capable of developing per square foot. This is all the more so in that fire-boxes with considerable grate area are as a rule less deep than others, because they must be above one axle or even above the trailing wheels, and it is a recognized fact that rapid combustion can only be successfully obtained in deep fire-boxes fitted with a brick arch and in which there is a strong draft.

The only way in which the grate area can be made greater than about 30 square feet, or at most 32 square feet, is to enlarge the grate itself beyond the limits dependent upon the distance between the frame plates or tires, and to do this we must fix the fire-box ring high enough to enable it to lie either above the frame plates or above the wheels. If the fire-box is situated completely above the frame plates, it can, consistently with the continued use of inside frames, be made as wide as in the case of outside frames. There is thus but little gained, and to make the alteration of much avail the grate must be put above the trailing wheels, which makes it possible to have the fire-box as wide in outside measurements as the available clearance allows. This is nothing new, for it was tried before by Mr. Petiet in France and shortly after in Belgium by Mr. Belpaire, who has made it a current practice during the last fifteen years. In the United States Mr. Wootten has gone a step further, which has enabled him to use a grate area of 86 square feet in some very powerful engines burning anthracite coal.

In Belgium they have confined themselves to applying the enlarged fire-box to engines with coupled wheels 5 feet 7 inches in diameter, or to express engines in which the fire-box only extended above a carrying axle mounted on wheels of small diameter, the fire-box not being enlarged in the part lying between the coupled wheels. This, however, necessitated having the center line of the barrel about 7 feet 10½ inches, or 8 feet ½ inch, which was at one time exceptional in Europe. In America they have gone still further; this arrangement is now used in 4 or 6-coupled express engines, with a wheel diameter of from 6 feet 2¾ inches to 6 feet 6¾ inches. The fire-box ring is thus as much as 6 feet 10 11-16 inches above rail level, and the center line of the boiler 8 feet 10 5-16 inches. Despite all this the fire-box is exceedingly shallow, and is hardly suitable for burning poor coal; and yet we must not lose sight of the principle that the locomotive, which ought to be kept as light as possible, ought also, if speed is to be increased, to be less heavy per unit of power, and it is essential to maintain rapid combustion in the fire-box unless the increased grate surface is intended to allow of poorer fuel being used, which is not what we are here considering. To accomplish this it is absolutely necessary to have the fire-box deep enough, and this cannot be done under the above circumstances without raising the boiler and center of gravity to an impossible extent, not to mention that the height of bridges would not always permit of such a large boiler.

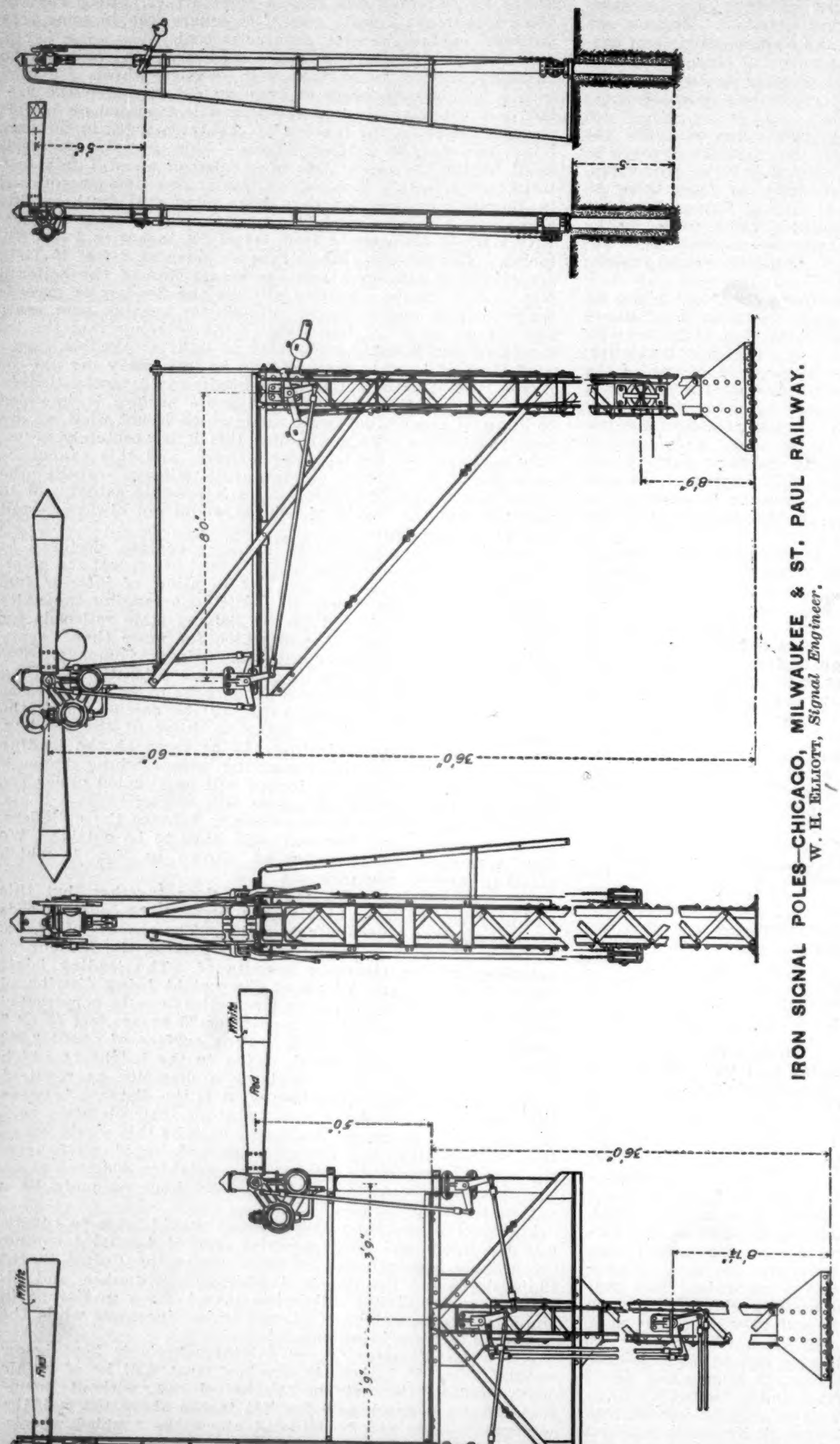
It appears, therefore, as if in future engines, designed to have very large grate areas and intended, we repeat the point, to have increased power, but not to allow of inferior fuel being used, we shall have to resort to arranging the axles after the fashion adopted by the Belgian state railroads for their engines of class 12, and which for more than twenty years has been customary with the Orleans Company. But it will also be necessary to make some alterations with a view to making the stability proportionate to future increases of speed. The two coupled axles will be carried under the barrel, the trailing wheels being in front of the fire-box, which it will be possible to make as large as the loading gage allows of. A pair of carrying wheels whose diameter does not exceed 4 feet 3¼ inches will be situated under the grate, and the front of the engine will be carried on a bogie, which will be all the more necessary because the cylinders, owing to their large diameter, will have to be outside. We thus arrive at an arrangement, shown in Fig. 1, which seems to meet all requirements.

The two coupled axles are very close together, but this will only tend to favor high speeds, because the coupling rods are less strained by centrifugal action. The absence of wheels of large diameter will permit of our making the fire-box as extensive as the clearance permits of. The leading bogie insures stability and allows of the weight being distributed properly. In this way express locomotives can be constructed with a grate area of as much as 65 or 75 square feet (6 or 7 square meters) and having a heating surface of about 2,380 square feet, while the barrel, owing to the height at which it is situated, can be of as large a diameter as required without our having to consider what is the distance between the tires of the coupled wheels, whether their diameter be 7 feet 2⅝ inches or more. An engine such as this would weigh from 65 to 68 tons in working order, and would, we believe, be capable of hauling express trains weighing 400 tons at an average speed of 46.6 or 49.7 miles an hour on main lines with average gradients.

Locomotives of this pattern, which would seem to constitute the latest and most powerful type of 4-coupled engine, are already beginning to be taken up in the United States Philadelphia and Reading, and Chicago, Milwaukee and St. Paul railways) and they will find increased favor in Europe in proportion as the weight of express trains increases while the speeds are far from being reduced.

When the diameter of the driving wheels is kept below about 5 feet 8⅞ inches the fire-box must still be of a fair depth, and as the axis of the barrel can, without inconvenience, be as much as 9 feet 2¼ inches above the rail, the enlarged fire-box can be situated above the coupled wheels, and no special arrangements are necessary either in the case of 6 or 8-coupled engines unless it be the use of a leading bogie or Bissel truck, which is needed to carry the additional weight due to the increased power of the boiler, so as not to make the load per axle too high. We thus come back to the recognized types, shown in Figs. 2 and 3.

We trust soon to be able to show by what means we may hope to extend the limits, wide as they still are, within which this class of engine is confined, and to show the possibility of building engines capable of developing as much as 2,500 indicated horse power.



IRON SIGNAL POLES—CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.
W. H. Elliott, *Signal Engineer.*

IRON SIGNAL POLES ON THE C., M. & ST. P. RY.

The large increase in the number of safety appliances introduced by the railroads of late years has resulted in a very great advance, not only in regard to certainty and precision of operation, but also in the matter of permanency of construction, with its resulting economy in the cost of maintenance. In no one direction can it be said to have advanced more than in the use of concrete and iron in substitution for wood. From a life of about six years, which is the average for wooden posts embedded in the ground, construction has advanced until now there is reason to believe that the probable life of the material used will be vastly increased. With most roads in this country signal work is of very recent date, so that the life of the material used was not considered as long as the desired stability of construction was secured. With the giving out of the wooden parts, however, and their comparatively short life the cost of keeping the work in good condition became manifest.

Among the first to advocate the giving up of wood, wherever other material could be conveniently used, was Mr. H. D. Miles, Signal Engineer of the Michigan Central Railroad, who read a paper on this subject before the Railway Signaling Club about two years ago, giving the results of his experience. While the roads have been rather slow in going into it, they have now progressed to such a point that the signal companies are prepared to furnish this class of work, and they are looking into the subject with the idea of making it their standard practice. The subject of iron poles in place of wood is now under consideration before the Signaling Club with a view to recommending standard dimensions so that uniformity of design may be secured. At present each road gets out its own designs and the ones here shown are adopted by the C., M. & St. P. Ry. as standard, having been prepared by Mr. W. H. Elliott, Signal Engineer of that road.

The drawings show the extreme simplicity of the design, the ease with which changes in connections can be made in the

field being readily seen. In place of the usual 10 by 10-inch wooden pole a pole made of 4, 5 and 6-inch pipe, having swedged joints 18 inches long, is used for the mast, one 32 feet long weighing but 550 pounds, and one 38 feet 660 pounds. The fittings, on which there is little machine work, are made to clamp the pole instead of screwing to it, the cap casting to which the ladder is fastened and through which the shaft to hold the arm plates is carried being slipped over the end of the pole and the joint filled with lead and calked, which gives an efficient yet easily made fastening.

It is on account of this fact of the easy method of fastening the different fittings to the pole that the cost of the 32-foot iron pole is brought down to about the cost of the same pole made of wood, for, while the pole itself costs one-third more than the wood, and the fittings for the iron pole are heavier, there is so little skilled labor required that the cost of fitting up is much less. For the 38-foot pole complete the cost is about $4.00, or 10 per cent less than wood, so that not only is the first cost, but also economy of maintenance, in favor of the use of the iron pipe pole.

The poles after being set in the ground are packed in around the bottom with concrete to make a block about 12 inches square to give a stable base and support the pole without looseness in the ground. That this is large enough to hold the pole firmly in place has been clearly proved from the large number now in service, none of which have given any trouble in this respect. To prevent rusting at the top of the cement wherever possible the concrete is brought above the ground to give a good slope and cause the water to drain off. When erected the poles present a remarkably fine appearance and are quite an improvement on the wooden ones. They are painted white, the same as the wooden poles, and seem to be as easily seen.

In the design of the bracket and offset poles the novelty in the departure from the use of wood is really less than with the straight pole, as such work has generally been made of iron. Although the actual cost cannot be given, as none have as yet been completed, it can be stated from careful estimates that their cost will be but little more than that of wood. The built-up posts and cross-arms only, such as can be contracted for with bridge building firms, weigh for the bracket pole 2,000 pounds and for the offset pole 1,990 pounds, which, at 2.2 cents per pound, makes the cost of poles, without 4-inch pipe or fittings, $44.00 and $43.78 respectively.

As will be seen by an examination of the cut, the post is built up of four 2½ by 2½ by ⅜ inch angles, the lacing being put on the outside and the post made straight so that the lacing strips will be of the same length and the rivet holes evenly spaced. For economy in construction none of the cross-arms or braces, with the exception of the two braces on the offset pole, are bent, the castings to hold the pipe posts being made wide enough to act as fillers and allow the several parts to be firmly bolted together. Using the same design of post for all bracket and offset poles, irrespective of the number of blades, reduces greatly the number of posts to be carried in stock, and with a few posts on hand almost any arrangement of signals may be readily secured by putting on the necessary fittings. These fittings are, for the most part, the same as those used on the pipe poles, or are of the common interlocking fittings, so that the parts necessary to fit up any kind of pole can be easily kept on hand. The matter of renewals in case of damage is also easily provided for, but few special pieces being required.

QUESTIONS ON TYPES OF WARSHIPS.

Mr. Charles H. Cramp, President of the Wm. Cramp & Sons, ship and engine builders, recently contributed the following views in regard to vital questions about warship construction, not yet settled, to the "New York Commercial:"

"The three cardinal points to be covered in a warship are offense, defense and sea-keeping power. The advantage of speed for both the Spanish and our own navy was much impaired by the condition of the ships, all of which were much hampered by barnacles. The ships were foul, and none of them could probably make more than half of the speed which they made when they were fresh from the yards and with clean bottoms. The last battle (Santiago) has not settled the question of the battleship against the cruiser, for the reason that I have just mentioned, and for the further reason that American gunners were much the better marksmen.

"The thoroughly satisfactory way in which the turrets of the vessels engaged worked is a source of great satisfaction to me. The problem of the turret was an important factor to be demonstrated in its application to modern warships, and this naval action has settled that question. It is impossible to give an accurate opinion on the technical aspect of the case until full details are obtainable, but one thing seems clear and that is that the gun and the man who works it are the great factors in a naval engagement."

The torpedo boat question he regards as still open. Our navy has not had the opportunity to demonstrate what it can do with these boats, and the failure of the Spaniards to do effective work with their torpedo boats and torpedo boat destroyers is no indication, he thinks, that our men would make a like failure.

THE APPLICATION OF ELECTRICAL MOTORS TO MACHINE TOOLS.

Since 1892 the Mulhausen Grafenstadten-Belfort Engineering Company have given special attention to the problem of using electric motors for the driving of machine tools, and a series of tests was made to find the best arrangement for varying the speed while obtaining the maximum possible efficiency. After general remarks concerning the various speeds and gears required for different types of machine tools, the author proceeds to describe actual tests of three methods of transmission: 1. Disk and plate. 2. Sellers friction. 3. Belt of trapezoidal section. In the first section the following were tested: a, sole leather on cast iron; b, compressed paper on cast iron; c, lignum vitæ on cast iron; d, hardened steel on cast iron; e, and the Sellers disk with cast iron on gun metal.

The electric apparatus consisted of a shunt wound motor for 110 volts and 3 horse-power at 1,200 revolutions per minute, a voltmeter for 120 volts, an ampere meter to read up to 7 amperes and one to read up to 25 amperes, with switches and adjustable resistance. The mechanical apparatus consisted of a bed plate carrying two Sellers bearings carrying a shaft, upon which was fixed a pulley with a Prony brake, a speed counter pulley and a lever arrangement to measure the end pressure exerted upon the driving gear. The pulley of the Prony brake ran in a bath of soap and water. The whole apparatus was designed to enable the co-efficients of friction of the various transmission mechanisms to be readily obtained. The whole of the calculations are given at great length, and finally the results are collected in tabular form and the values are given for horse powers varying from 0.5 to 2.5. From these the following results for 2 horse-power may be selected as fairly typical:

E. H. P.	B. H. P.	Coefficient of friction.	Efficiency.	
2.961	2.130	0.339	0.7193	Disk and roller, leather on cast iron.
2.764	2.113	0.420	0.7644	Disk and roller, compressed paper on cast iron.
2.764	2.115	0.352	0.7688	Disk and roller, lignum-vitæ on cast iron.

From the series of results given in the original the author concluded that the disk and roller are suitable, under certain conditions, for altering speeds for motors up to 2 horse-power.

With respect to Sellers disks, the author concludes that the efficiency is lower than that of the disk and roller, but that the apparatus may be used for small powers at speeds not exceeding 1,000 revolutions per minute. The experiments on the transmitting powers of leather belts of a trapezoidal or wedge section are compared with similar results obtained for ordinary flat leather belts. The belt groove has sides inclined to one another at 40 degrees. The belt speeds were 1,236, 2,472 and 4,944 feet per minute. With the apparatus in question it was not possible to obtain the co-efficient of friction for the belts, but it was clearly proved that their efficiency was far greater than those of the other methods already described. The author describes various forms of machine tools, and points out how much less room speed cones for wedge shaped belts take up than cones for ordinary belts.—Inst. C. E., Foreign Abstracts.

COMMUNICATIONS.

ADVANTAGES OF RELATIVELY SMALL GRATES.

Editor "American Engineer":

I was very much interested in a letter in regard to grate surface on page 260 of your August number. It carries out exactly what I have always held, and I believe I was the first to "preach" the question of grate surface in season and out of season. The Master Mechanics are all right when they call for large fire boxes to burn the bituminous coals, but the large fire boxes do not necessarily involve large grate surfaces. Some of the engines we are running now we have blocked up fully three feet in length of the grate surface, and are letting in an amount of air over the fire that would astonish the average Master Mechanic.

One engine which we have recently fitted up for lignite carried her train up a one per cent. grade with the fire box door open the whole time, showing that quantities of air could be used without cooling the flues.

C. M. HIGGINSON,
Assistant to President A., T. & S. Fe Ry.

Chicago, August 3, 1898.

THE GOVERNMENT AND THE METRIC SYSTEM.

Editor "American Engineer:"

I have read the proof of Mr. Grafstrom's article entitled "A Chapter in Metrology" with much interest. In the main, I think his views are very reasonable, but I differ with him in his conclusion that the Government cannot at present properly take further steps in reference to the introduction of the metric system.

There is one very important step which is quite possible, and provision for which is made in a bill already before the Committee on Coinage, Weights and Measures in Congress. I refer to the official adoption of the metric system of weights and measures by the Government itself. I do not mean the simple adoption of the meter and kilogramme as final standards, which has already been accomplished; but I mean the official use of the metric system in the custom houses and in all other operations with which the Government has to do, except, as is provided in this bill, the office of Land Surveys, in which at present, at least, it would appear to be wise to continue the prevailing units. For several years the officers of the Government in the several bureaus which would be affected by such legislation have been practically unanimous in their desire to have the metric system adopted. All customs officers know that its adoption would be the means of preventing many annoying errors that are now continually made in the translation from the metric system to our own, and that it would greatly simplify all operations relating to importation, and undoubtedly create trade with metric-using nations. This step the Government might easily at any time take. It would do more, in my judgment, than anything else to bring the metric system to the attention of the general public, and would result in a very short time in a good degree of knowledge of the system on the part of the commercial public, together with a desire on their part to have the advantages of the improvement.

If this step were taken promptly, and at the same time efforts were made to secure instruction in the public schools of the country in the metric system and its use, I believe that its introduction would be general in the very near future. Many of our manufacturers are already using it; some of them are publishing catalogues of their products in which metric units are used, discovering, as they have, that it is necessary to do this in order to meet the demands of foreign trade. As Mr. Grafstrom says, the English have already found this out, and progress along the line of metrological reform is very active in Great Britain at the present time. It, therefore, does not seem at all impossible or improbable that with the adoption of the use of the system by the Government itself its final acceptance by the whole people may come sooner than many would imagine.

It is not impossible for the Government to follow the example of several European nations in making the system obligatory after a certain period of years. I am very sure that, with the adaptability and quickness of comprehension of the American people, especially the American workingmen and those who have to do with the smaller affairs in commerce, five or ten years' notice of the adoption of this system would be unnecessarily long. It must not be forgotten that in the earlier history of our country, when we were much less prepared to appreciate such advantages, the change was made from the English system of currency to our present decimal system with little or no difficulty. It has never been my idea that when the system was adopted by the Government all use of the ordinary units of weight and measure would immediately disappear. There would be no harm in and no legal obstacle to the continued use of pounds, feet and inches among those who desired to do so, just as there is now nothing to prevent any two persons doing business with each other in terms of the Chinese units of weight and measure if they so desire. In the history of our own money system it is well known that the older units were a long time in disappearing, but that now, after many years, they have practically gone. No one, I am sure, would desire to see their return. Something of this kind would be the result in the case of the adoption of the metric system by the United States Government, provided ample time was given for preparation.

T. C. MENDENHALL.

Office of the President.
Worcester Polytechnic Institute, Worcester, Mass, Aug. 15, 1898.

DRIVING AXLES AND CRANK PINS.

Editor "American Engineer":

I was much interested in Mr. Cole's presentation of the subject of "Strength of Driving Axles" in your June issue, but it seems to me that one point of considerable importance has not been referred to in this article. In the lower part of the right hand column on page 202, the bending strain upon the main axle is considered as being caused by the piston pressure divided by the number of driving axles, into the lever arm, or the distance between the centre of main rod bearing and centre of journal bearing. This is correct as long as the parallel rods are all well fitted and free from play or lost motion on the pin; but if there is any considerable amount of slack due to wear in the crank pin brasses of bushings, the conditions would be very much more severe for the main axle.

Let us consider, for instance, that there is a certain amount of slack in the main pin side rod bearing and possibly also in the other side rod bearings, but either will not make much difference in the following argument. When the side rods approach the dead center, the slack, of course, is behind the pin in reference to the direction in which the pin is moving, and as soon as the steam pressure comes upon the piston at the commencement of the stroke, there would be nothing back of the pin to help resist this load. We, therefore, see that at this instant the total bending moment on the axle will be due to the full pressure of the piston on the pin regardless of the number of coupled wheels on that side of the engine, and, therefore, the main axle will be called upon to resist a proportionately greater strain than under normal working conditions. If the axle and driving box are a neat fit, the conditions will be worse than if we consider them as having a certain amount of play which would enable the axle and driving box to move in the pedestal and help distribute the load through the parallel rods. Therefore, it seems to us that the condition is certainly likely to occur, as we know from experience that side rods will often be allowed to run with a good deal of lost motion, and this fact should certainly be considered in fixing upon the proper size and material of which to make the main axle.

The same thing refers in a less degree to the subject of crank pins treated in the May issue, whereby the slack or lost motion in the side rod causes the lengthening of the lever arm of the piston pressure, and we think there is sufficient importance in this matter to cause it to be considered when designing these parts of locomotives.

G. R. HENDERSON,
Mechanical Engineer.

Norfolk & Western Railway, Roanoke, Va.

[A proof of Mr. Henderson's communication was sent to Mr. Cole and we print his reply below.—Editor.]

Editor "American Engineer:

I am glad of the opportunity to answer the question Mr. Henderson asks in the above letter discussing the strength of driving axles.

It is often better to reason from known facts and base our conclusions upon them than to assume certain conditions which are not so clearly established. It seems more desirable to assume normal conditions for the working stresses, and keep the fiber stress at such a low figure as to give an ample margin of strength to resist the abnormal and extraordinary stresses which may occur from time to time.

In a locomotive having but one pair of drivers the entire piston thrust must evidently be resisted by the one crank pin and axle. The bending moment is the thrust of the piston multiplied by the lever arm; the maximum fiber stress caused by

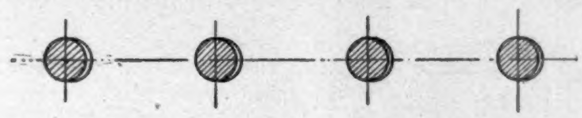


Fig. 1.

this force is the bending moment divided by the modulus of section of the axle when worn out. If the tractive force exceeds the resistance caused by the adhesion of the wheels, slipping will take place. In ordinary types of engines having two or more pairs of drivers, the parallel rods transmit to the other pairs of wheels a proportional amount, so that each pair has to resist an equal turning moment. It is a generally accepted proposition that an equal force is transmitted to each pair, or that the maximum turning moment on any pair is equal to the piston thrust divided by the number of pairs of drivers. This fact being established, it follows that the parallel rod prevents the entire thrust being borne by the main axle and transmits it equally to all the drivers. If the lost motion is excessive, or if a lack of parallelism exists between the axles and the crank pins, slipping will take place at every revolution to adjust the irregularities. The stress on the main axle under these conditions will be increased up to the limit of adhesion, an excess amount probably not exceeding 25 or 30 per cent. of the normal stress.

When the crank is on the dead center the effect of lost motion in the rods or driving boxes is felt at its maximum. It is probable that ordinarily when there is much lost motion in the parallel rod bearings, the main axle will be also loose enough in its box to allow the load to be distributed among the drivers as at other portions of the stroke. There is also a certain amount of spring or deflection in the axle and crank pin, which occurs before the maximum stress is reached, and assists materially in equalizing the pressure between the drivers, taking up in a de-

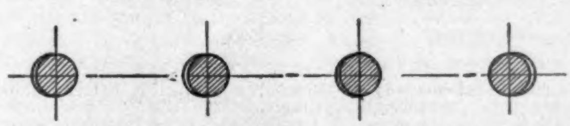


Fig. 2.

gree the lost motion in the rod bearing. The possibility of overstrain in the main axle due to excessive slack in the parallel rod bearings, was carefully considered in the suggestion that the fiber stress should be decreased as the number of axles increases.

Mr. Henderson assumes that only the main axle is subjected to increased stresses due to excessive slack or improper adjustment, whereas, under certain conditions any of the other axles may be required to resist considerably more than their normal loading. Fig. 1 shows the crank pins of a consolidation engine at the commencement of the stroke, with an equal amount of slack in front of all the pins. This is the condition assumed by Mr. Henderson. It is evident, however, that a slight looseness in the main driving-box and spring in the pin and axle will in most cases prevent the entire piston thrust from being resisted by the main axle.

Fig. 2 shows the slack on the back of the main, second and fourth, and in front of the first pair. Here the first axle has to withstand an overload, unless relieved by looseness in the boxes or springing.

In Fig. 3 the slack is back of the main, first and second, and in front of the fourth pair, the latter axle having to withstand the overload.

Were it a fact that the working stress on the main axle of a consolidation engine should be taken as the entire piston thrust, irrespective of the number of axles, it could be shown by a number of instances of engines which have been in service for 15 or 20 years, during which time comparatively few breakages have occurred, in spite of the fact that the assumed stresses would figure up to 30,000 to 32,000 pounds per square inch for hammered iron axles, undergoing, roughly speaking, about 12 millions of repetitions of alternating loads per year.

The ability of wrought iron to resist repeated changes of loading is now so well known that it is unnecessary to go into details, but merely to state that breakages may always be expected to occur after a few million changes of load at from 16,000 to 25,000 pounds stress per square inch, the former being for reversing or alternating tension and compression, and the latter a load applied and entirely removed, but always acting in the same direction.

An axle under a freight locomotive is subjected to an alternating stress in which the reversals, although they do not reach the maximum yet when the engine is moving slowly and cutting off steam at, say, 80 per cent., do reach 50 or 60 per cent. of the maximum stress acting in the opposite direction. The breaking stress after two or three million repetitions could, therefore, reasonably be taken at about 20,000 pounds per square inch for good wrought iron. This is the breaking load for this range of stress as opposed to the static breaking load once applied, as seen in the testing machine, and known as the ultimate strength of the material, neither having any margin of strength or factor of safety, the latter breaking quickly with a single load steadily applied and not removed until after fracture, and the other breaking equally as surely, although not so quickly, after the required number of changes of load have taken place.

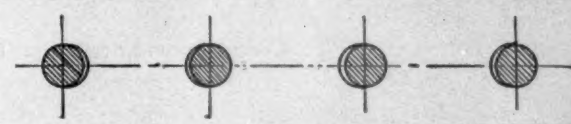


Fig. 3.

Again, the working stress of an axle can be approximately determined by the amount the rear axle of an eight-wheel engine can withstand, the parallel rod transmitting the force and the pin and axle being, therefore, entirely unsupported. Here instances can be cited where fractures usually occurred with iron axles when the stress exceeded 12,000 or 13,000 pounds. It seems unreasonable, therefore, to consider it necessary to design the main axle of a consolidation engine to resist the entire piston thrust unaided by the parallel rod, and keep the fiber stress down to, say, 8,000 to 10,000 pounds per square inch, figures which would usually be considered the maximum safe stress for this manner of loading. Taking the higher figure of 10,000 pounds, a mogul, consolidation or 10-wheel engine having 20-inch cylinders, steam pressure 200 pounds and a lever arm of 21 inches (center of main rod to center of frame), would require an axle of 11 inches diameter when worn down to the limit to resist the piston thrust alone.

For crank pins the support of the parallel rod was duly considered. On engines having the main rod outside it is comparatively small, so that the simplest method is to disregard it and use a higher working stress, as suggested in page 125 of the April number, and shown graphically in Fig. 6, page 154, of the June number. The distance from the wheel face to the center of the parallel rod is usually from 2 to 3 inches, making the counter-moment small in proportion to the bending moment, so that, after all, the real question is whether it is more desirable to use the higher stress without and the support of the parallel rod, or the lower stress, when it is taken into consideration. The latter seems to me the more rational, although more complicated, method.

Paterson, N. J. F. J. COLE.

Pneumatic tubes for the transmission of mail between the New York and Brooklyn Postoffices were put into service Aug. 1. The tubes pass over the Brooklyn Bridge, and are provided with three expansion joints on the structure. The cost of the plant, including the double-pipe system, was $60,000, and the annual rental paid to the New York Newspaper and Transportation Co. for carrying first-class matter is to be $14,000 for a three-years' lease. The system is similar to that illustrated in our issue of November, 1897, page 379.

CONSOLIDATION LOCOMOTIVES—BURLINGTON & MISSOURI RIVER RAILROAD.

The Burlington & Missouri River Railroad has just received one of four consolidation engines recently designed and built by the Pittsburgh Locomotive and Car Works. They are for freight service in the Black Hills and it is expected that they will haul 50 per cent. more cars than the consolidation engines now in use there are handling on the limiting grades. The new engines weigh 180,000 pounds and are heavier than any hertofore used on the Burlington and are among the heaviest ever built in weight upon drivers. Comparisons in regard to weight and leading dimensions, which may be made by aid of the table printed here and also that on page 1 of our January issue of this year, will be interesting.

The new Burlington engines have 22 by 28-inch cylinders and large boilers with the firebox above the frames and with unusually long tubes. While the heating surface has been exceeded in earlier designs, 2,675 square feet places the engine among the largest in this respect. In considering the weight of the engine it should be noted that all but 15,200 pounds comes upon the driving wheels for useful adhesion. Among the noticeable features shown by the photograph are extended piston rods, a comparatively short front end, a separate dome for safety valves and whistle, alligator crossheads, automatic couplers. These engines have been built under the direction of Mr. G. W. Rhodes, Superintendent of Motive Power, Chicago, Burlington & Quincy Railroad.

The following table gives the leading dimensions:

Description.

Type........................Consolidation
Number built........................Four
Name of builder........................Pittsburgh Locomotive Works
Gage........................4 feet 8½ inches
Simple or compound........................Simple
Kind of fuel to be used........................Bitumir ous Coal
Weight on drivers........................166,000 pounds
" " truck wheels........................15,200 pounds
" total........................181,200 pounds
" tender loaded........................94,200 pounds
Wheel base, total of engine........................23 feet 6 inches
" " driving........................15 feet
" " total (engine and tender)........................53 feet 2 inches

Consolidation Locomotive—Burlington & Missouri River Railroad.

PITTSBURGH LOCOMOTIVE WORKS, *Builders.*

Length over all, engine........................40 feet 4¼ inches
" " " total, engine and tender........................62 feet 7¾ inches
Height, center of boiler above rails........................8 feet 9⅝ inches
" of stack, " "........................15 feet
Heating surface, firebox........................188.6 square feet
" " tubes........................2,486.4 square feet
" " total........................2,675 square feet
Grate area........................31.6 square feet
Drivers, number........................Eight
" diameter........................52 inches
" material of centers........................Cast-iron
Truck wheels, diameter........................30 inches
Journals, driving axle, size........................9 by 10 inches
" truck " "........................5½ by 9 inches
Cylinders, diameter........................22 inches
Piston, stroke........................28 inches

TABLE OF COMPARISON OF HEAVY LOCOMOTIVES.

Builder and type / Railroad	Brooks, simple. Mexican Central.	Schenectady, compound. N. P. Ry.	Pittsburg, simple. B. & O. R. R.	Pittsburg, simple. D., M. & N. Ry.	Baldwin, simple Buffalo & Susquehanna.	Schenectady. simple. D. & I. R. R. R.	Brooks, simple. Great Northern.	Simple. P. R. R. H-5.	Pittsburgh, simple. B. & M. R.
Total weight	193,450 lbs.	186,000 lbs.	168,000 lbs.	160,000 lbs.	163,550 lbs.	169,000 lbs	212,750 lbs.	208,000 lbs.	181,200 lbs.
Weight on drivers	145,200 lbs.	150,000 lbs.	152,800 lbs.	144,000 lbs.	147,250 lbs.	139,000 lbs.	172,000 lbs.	186,000 lbs.	166,000 lbs.
Size of drivers	49 in.	55 in.	54 in.	50 in.	51 in.	54 in.	55 in.	56 in.	52 in.
" cylinder	21 × 26	23 × 34 × 30	22 × 28	22 × 28	22 › 26	22 × 26	21 × 34 in.	23½ × 28 in.	22 × 28 in.
H. S. firebox	218 sq. ft.	206.51 sq. ft.	183.64 sq. ft.	169.5 sq. ft.	189.5 sq. ft.	189.7 sq. ft	235 sq. ft.	197 sq ft.	188.6 sq. ft.
" total	2,803 sq. ft.	2,943.41 sq. ft.	2,315.64 sq. ft.	2,318.7 sq. ft.	2,244 sq ft.	2,402.3 sq. ft.	3,280	2,721 sq. ft.	2,675 sq. ft.
Firebox	37¾ in. × 120 in.	42 in. × 120$\frac{3}{16}$ in.	41 in. × 115 in.	42¼ × 121 in.	42 × 121.8 in.	41⅜ in. × 120⅛ in.	10 ft. 4 in. × 3 ft. 4½ in.	10 ft. × 40 in.	9 ft. 6 in. × 40 in
Grate area	31.45 sq. ft.	35 sq. ft.	32.7 sq. ft.	35.5 sq. ft.	35.3 sq. ft.	34.5 sq. ft.	34 sq. ft.	33.3	31.6 sq. ft.
Steam pressure	180	200	180	160	180	180	210 lbs.	185 lbs.	180 lbs.
Size of boiler	78 in.	72 in.	64 in.	72 in.	72 in.	72 in.	78 in.	71 in.	74 in.
Kind "	Belpaire.	Extended wagon top.	Extended wagon top.	Straight.	Straight.	Straight,	Belpaire.	Belpaire.	Belpaire.
Staying	...	Radial.	Radial.	Radial.	Radial.	Radial.	...	...	...
Tubes	412, 2 in. diam. × 12 ft. 1¼ in.	332, 3¼ in. dia. × 14 ft.	246, 2¼ × 14 ft. 8½ in.	272, 2¼ × 13 ft. 6 in.	260, 2¼ × 13 ft. 6 in.	280, 2¼ × 13 ft. 6 in.	376, 2¼ in. dia. × 13 ft. 10⅝ in.	306, 2⅛ in × 14 ft.	292, 2¼ in. × 14 ft. 6½ in.

Valves........................Richardson Balance
" greatest travel........................5 inches
" outside lap........................¾ inch
Boiler, type of........................Belpaire
" working steam pressure........................180 pounds
" material in barrel........................Steel
" diameter of barrel........................74 inches
Firebox, length........................9 feet 6 inches
" width........................3 feet 4 inches
Tubes, number........................292
" outside diameter........................2¼ inches
" length over sheets........................14 feet 6½ inches

Tender.

Tank capacity for water........................5,000 gallons
Coal capacity........................17,500 pounds
Type of truck spring........................Semi-Elliptic

Diameter of truck wheels	37 inches
Diameter and length of axle journals	4¼ by 8 inches
Distance between centers of journals	6 feet 3 inches
Diameter of wheel fit on axle	3⅝ inches
Diameter of center of axle	4⅝ inches
Length of tender frame over bumpers	22 feet 3½ inches
Length of tank	19 feet
Width of tank	9 feet 6 inches
Type of back drawhead	M. C. B. Coupler

MECHANICAL DRAFT.*

By W. B. Snow.

The substitution of the fan for the chimney as a means of draft production marks a distinct advance in the convenience and economy of steam generation.

Mechanical draft may, in stationary practice, be applied in either of two ways: First, by forcing the air into a closed ashpit, and maintaining therein a pressure in excess of the atmosphere; and second, by exhausting the air and gases from the flue or uptake and thereby creating a partial vacuum, which causes a constant inward flow of air in the combustion chamber. The former is designated as "forced draft" and the latter as "induced draft." Under certain conditions a combination of the two methods may be found desirable. The natural result of the application of a centrifugal fan in either manner is to render the draft conditions positive at all times. A fan of the disc or propeller type is entirely inadequate for such work.

On the erection of a chimney the first matter to receive consideration is the foundation. This always represents a comparatively large, and in the case of unstable ground an abnormally excessive proportion of the expense of the entire structure. A fan, on the other hand, is relatively light, requires no expensive foundation, and may in many cases be located upon the top of the boilers.

The portable character of a mechanical draft apparatus renders it not only valuable as an available asset, when it is no longer required in a given location, but makes possible its relocation or arrangement in a manner that is absolutely impossible in the case of a chimney, which must always stand as a monument to a departed industry or an abandoned means of draft production.

The primary duty of the chimney is to create sufficient draft, while its secondary office is to remove the gases and smoke to a proper height for discharge to the atmosphere. The height required for this purpose is almost universally less than that necessary to produce the draft. Obviously a stack of decreased height and cost will serve the purpose with mechanical draft. In fact, a sheet iron pipe extending but a few feet above the top of the boiler house will in most cases fulfill the requirements.

The steel plate construction which is common to most fans employed for producing draft makes it possible to readily design and build them to exactly suit any given conditions. Such a fan may be arranged to be driven by a belt or by a direct-connected engine, as may be desired, may be automatically controlled in its speed to meet the requirements of steam generation, and may be increased in capacity by the simple transmission of more power.

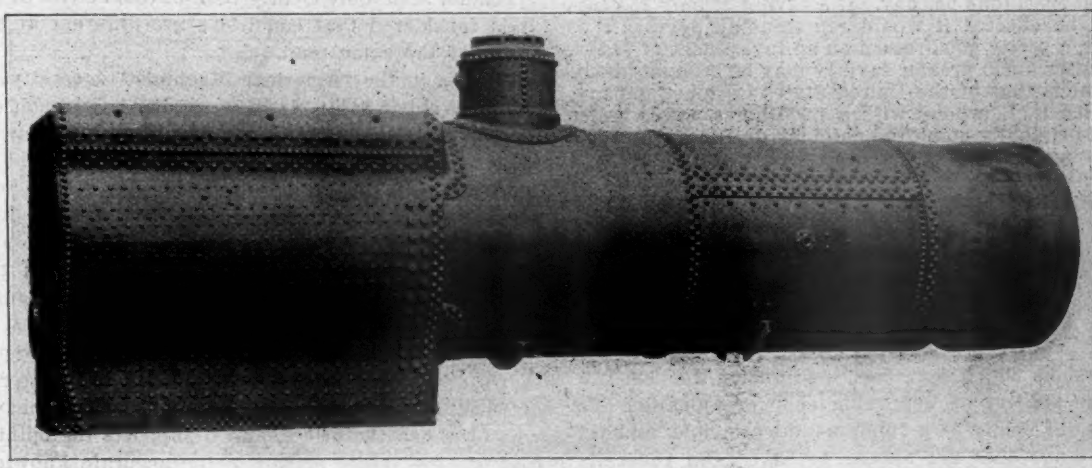
Another feature of convenience resulting from the employment of mechanical draft is to be found in the ability to burn cheap fuels which are almost invariably of small size and require an intensity of draft which is not readily created by means of a chimney. The economic value of this and the preceding features of convenience will be considered as we proceed.

We may now turn to the distinctly economic aspects of the installation of mechanical draft, and of necessity these must be considered relatively to those incident to the use of a chimney. Employed solely as a means of creating air movement the chimney is most absurdly inefficient. It may be readily shown that under the ordinary conditions of boiler practice an engine-driven fan will move a given amount of air with the expenditure of about one-seventy-fifth as much power. This immense advantage of the fan over the chimney may be turned to good account by introducing proper devices for transferring the heat of the gases to the feed-water or to the air supplied to the fire, and the gases may, with fan draft, be cooled to a temperature far below that which could be attained with a chimney without too seriously reducing its draft. Tests of nine large boiler plants equipped with economizers and mechanical draft are reported by Roney to have shown on an average a saving of about 14 per cent. In connection with a plant of such size the steam required for the operation of the fan, with an efficient engine, can be kept within 1 per cent. of that generated by the boilers to which it is applied.

Custom and the expense of high chimneys are, doubtless, responsible for the comparatively low combustion rates which prevail in most steam plants. It may be fairly stated that to double the rate of combustion on a given grate area, it is necessary to make the chimney about three times as high, at a cost perhaps five times as great. In the case of a fan the same result could be obtained without even so much as doubling the cost. This clearly points to the economy to be secured by properly designing the boilers, increasing the combustion rate and securing a greater output from a given size boiler and for a stated investment. Low combustion and evaporation rates are not essential to high efficiency. Within reasonable limits the higher the rate of combustion, the less is the volume of air required per pound of coal. The fire is of necessity deeper, the draft is stronger, and each individual particle of air has increased opportunity to come in contact with the fuel. With a decreased supply of air the intensity of the fire is increased, its temperature is higher, more heat is radiated to the exposed boiler surfaces and more is taken up by the gases, which, because of less ultimate volume, move at lower velocity and thus have more time to part with their heat. As regards the economy of evaporation, F. R. Low has shown that in the case of thirty Babcock & Wheeler boilers practically as good results were obtained at a rate of 5 pounds per square foot of heating surface as at the rate of 1.75 pounds.

When a fan is employed as a means of draft production it may, at comparatively small expense, be installed of such size as to possess an emergency capacity which, if embodied in the boilers, could only be provided at vastly greater first cost, with incident larger fixed charges.

In order that a definite comparison may be made between the two methods of draft production, a certain 1,600 horse-power plant has been taken, of which the cost is known. This consists of eight modern water-tube boilers, two economizers and a chimney 8 feet in diameter by 180 feet high. The latter is located just outside the boiler house wall. If a duplex induced mechanical draft appartus, each fan capable of operating the entire plant, should be substituted for the chimney, it could be placed immediately above the economizers, and with its attached engine could be rigidly supported by beams resting on the economizer walls. A short stack would serve to discharge the gases above the roof.



Boiler of Consolidation Locomotive—B. & M. R. R. R.

* From a paper presented before the Northwestern Electrical Association, June, 1898.

The cost of the chimney, with damper regulator and dampers, is $9,300; that of fans, engines, draft regulation and short stack, installed complete, would be about $3,500, or only 38 per cent. of the draft producing apparatus for which it is substituted. That is, the saving would be $5,800.

With the increased draft produced by the fans it would be possible to raise the combustion rate and the steaming capacity, or what is equivalent, the steam capacity might be maintained with a less number of boilers. Suppose one of the eight boilers be omitted from the original design, making the plant 1,400 nominal horse-power, a further saving of about $4,000 may thus be secured.

If the land be valuable, the reduction of space incident to the employment of mechanical draft may have an appreciable effect. If worth—say $2 per square foot, the saving by omission of chimney and one boiler would be about $2,000. The total saving in first cost resulting from an expenditure of $3,500 for mechanical draft may thus be shown to be $11,800; that is, the saving is nearly three and a half times the expenditure necessary to secure it. Obviously, there is a coincident reduction in the fixed charges for interest and taxes.

The power expenditure for operating the fans should be practically inappreciable in any well-designed plant in which provision is made to utilize the exhaust steam from the fan engine.

The most direct saving in operating expense which may be secured by the introduction of mechanical draft is that resulting from the utilization of cheaper fuel. Such a plant as previously described would, under good conditions, probably, require at least 8,000 tons per day. If a saving of only 25 cents per ton could be effected it would represent an aggregate of $2,000 per year, a pretty good return on an investment of $3,500. But in many cases much greater savings may be brought about. A case in point is that of the United States Cotton Company, at Central Falls, R. I., where, with a 1,000 horse-power boiler plant, the fuel originally employed chimney draft was George's Creek, Cumberland, costing $4 per ton. With forced draft, a mixture of No. 2 buckwheat screenings and Cumberland is now used, costing $2.62 per ton. The saving has been about $125 per week, enough to pay for the special steam fan in about six weeks.

IMPORTANCE OF KNOWING COSTS OF SHOP OPERATIONS.

In the discussions which have been held during the past few years upon the subject of improving shop organization one feature stands out boldly as a fundamental principle, and yet its real importance does not appear to have been generally recognized. This is the importance of knowing present costs as a basis upon which to build improved methods. In his paper before the Western Railway Club, published in our November issue, 1897, Mr. L. L. Smith says of the railroad officer: "In order that he may intelligently devise ways and means for the reduction of the cost of work, he must first determine what the work is actually costing under existing conditions. By being armed with this information he is not obliged to deal and argue entirely in generalities. This information is of great value alike to the superintendent of motive power, the master mechanic and the foreman. The importance of knowing what work costs cannot be too strongly emphasized. The piecework principle is the embodiment of this idea, but even the most ardent opponent of the piecework plan cannot consistently object to determining what his work is costing."

The piecework plan often fails, and it is not too much to say that it is predestined to failure when it is not based upon accurate knowledge of the cost of work. It is necessary to add somewhat to the clerical force in order to keep track of the cost, and if the financial advantage of doing this was appreciated the small expense would surely not be an obstacle. Mr. Fred W. Taylor spoke with authority when he said before the American Society of Mechanical Engineers in 1895: "How few of them (manufacturers) realize that, by the employment of an extra clerk and foreman, and a simple system of labor returns, to record the performance and readjust the wages of their men, so as to stimulate their personal ambition, the output of a gang of twenty or thirty men can be readily doubled in many cases, and at a comparatively slight increase of wages per capita."

This authority also says that the most formidable obstacle in carrying out a piecework system is the lack of knowledge on the part of both the men and the management, but chiefly the latter, of the quickest time in which each piece of work can be done; or briefly, the lack of accurate time tables for the work of the place.

The way to remedy this trouble is to place the matter of prices in the hands of an individual or a department having the necessary experience, information and authority to establish the prices upon a basis which shall be an incentive to the men and at the same time shall be fair to the employer, and shall not require adjustment until some new method or process brings a new element into the work to change its cost. Not the least value of Mr. Smith's paper is the description given whereby it is clearly shown that the Chicago, Burlington & Quincy Railroad officers correctly estimate the piecework system, and that a specialist has been appointed to establish it.

The great number of important duties devolving to-day on a Master Mechanic renders it unreasonable to expect him to look after details requiring such careful study as must be given to such subjects. This work requires the undivided attention of an expert, who must familiarize himself with all of its details. The work of busy railroads requires more and more specialization, and nowhere is the necessity for a specialist seen more clearly than in this matter of prices, when it is considered that conditions are different at the different shops of the same road.

Writing in the "American Machinist" several years ago Mr. W. O. Webber said: "It is surprising how much can be done by one smart young man who has some experience himself in shop work, in discovering and plugging up the leaks in a machine shop, by taking the time slips from each man and playing a sort of game of solitaire with them to determine the exact value of the different manipulations." He also remarks upon the surprising interest which foremen, if they are interested at all in their work, take in these figures and try to find remedies for defects.

A reason offered by officers who do not favor piecework is that some have tried it and have failed to secure reduced cost of work. This is not the fault of piecework, but of the men who establish the prices, and it supports the opinion that the root of the whole matter is the accurate knowledge of the cost of each operation.

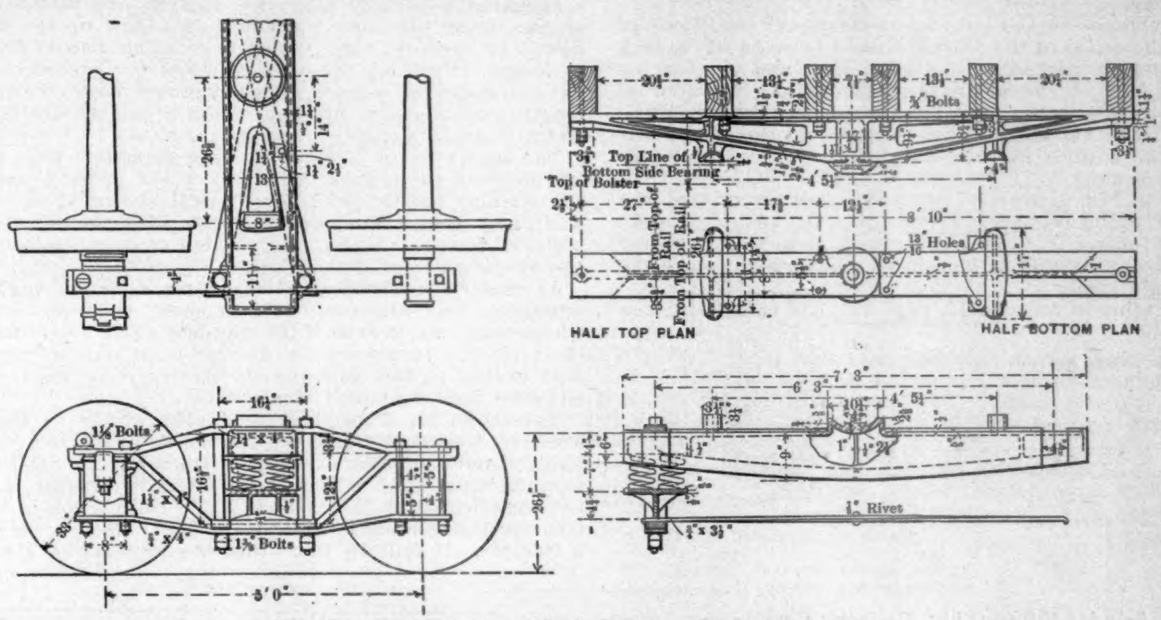
Reference has been made to the differences in costs in different shops of the same road. There are reasons why differences of results will exist on roads that are long enough to pass through sections of the country so widely separated as to introduce different scales of prices at the different shops. The fact is well known, however, that the variation of wages will not account for all of the differences, and much may be accomplished by closely comparing the work of different shops after taking the wages into account. The frequent meetings of the officers for discussion of practice is now recognized as a necessary factor in railroad work, and whether it be among superintendents of divisions, officers of bridge departments, master mechanics or master car builders, the comparison of the cost of the work done by each is as important a subject as may be found, and in the order of important duties it should be placed next to those which have to do with safety of operation.

A new six-inch rapid-fire wire-wound naval gun has been adopted by the English Navy. The tests, which were very thorough, show that the gun may be fired at the rate of one round in eight seconds and after 200 rounds the accuracy of fire was not affected. A velocity of 2,780 feet per second pressure of 15.9 tons and striking energy of 5,374 foot tons have been obtained. The breech is opened and closed by a single motion and the primer tube is automatically covered until the breech plug is locked. The gun does not require cartridge cases, which is a favorable feature, owing to their weight in the magazines and the usual complication necessary to eject the empty case from the breech of the gun.

FREIGHT TRUCK, CAST STEEL TRUCK AND BODY BOLSTERS—SEABOARD AIR LINE.

Through the courtesy of Mr. W. T. Reed, Superintendent of Motive Power of the Seaboard Air Line, we have received the drawings of a freight truck for 60,000 to 80,000 pound capacity cars, which are reproduced in the accompanying engravings. The older trucks with sandwich bolsters, which the present design replaces, had a total of 114 pieces, including everything from the center plates to the wheels, whereas the one illustrated has only 83.

The truck is of the arch bar type, with cast steel end castings, which combine the column guides and spring seats in a single piece fitting neatly over the ends of the bolster, with the column bolts passing through the arch bars to form an excellent arrangement for maintaining the alignment of the truck. Instead of a spring plank, which in this arrangement is unnecessary, lateral bracing is provided by two diagonal bars of ¾ by 3½-inch iron, crossing at the center, where they are riveted together. The truck and body bolsters are of solid cast steel, which together with the end castings were furnished by the American Steel Foundry Co. of St. Louis. The truck bolster combines the center and side bearings, brake hanger and guide lugs in a single piece, greatly reducing the number of pieces. The body bolster, the construction of which is clearly indicated in the drawing, is also cast in one piece, carrying out this idea still further.



New Standard Truck and Body Bolsters—Seaboard Air Line.
BY THE AMERICAN STEEL FOUNDRY CO.

The great importance of keeping the side bearings clear of each other was shown by the remarks of Mr. A. E. Mitchell at the recent convention of the Master Car Builders' Association. It was also shown in a recent discussion before the Western Railway Club, a report of which will be found elsewhere in this issue. It is evident that it is not sufficient to have one of a pair of bolsters of the requisite stiffness, but both the body and the truck bolster must be so designed as to hold the loads without allowing the side bearings to come into contact. The truck and the body bolster are intended to have corresponding capacities, which are so far above the requirements of cars of this size as to positively insure against permanent set. The object is to fulfill the conditions that the Master Car Builders are seeking to provide for, namely, to carry the loads on the center plates.

While the stated capacity of these cars is 60,000 pounds, the manufacturers of the bolsters guarantee them for 80,000 pounds, and base a strong claim for economy on their ability to carry the heavier loads. They guarantee the bolsters to outlive the cars (not even excepting wrecks), and state that when the capacities of the cars are increased in the natural course of progress, the trucks, which are the most expensive parts of the cars, will be ready to receive new bodies of greater capacity, with only an increase of the size of the axles.

Our drawings show the construction of the trucks so clearly as to require no further explanation, but we will quote from a letter received from Mr. Reed, as follows:

"The idea of applying such bolsters to freight cars is to dispense with the many parts which require additional labor on trucks used previously of the same pattern as far as the arch bars were concerned, with flitch plate bolsters. . . . . The time has now arrived when mechanics can readily see the advantages to be gained in the minimum number of pieces in any part of a truck or other machinery, and it is to this end that I find it most advantageous. What we need is a truck that will stand all abuses possible after derailments, so that the trucks may be replaced on the tracks and continue their journey while others must be taken apart. We have several of these trucks in fast freight service, and have no reason to complain of their standing up under from 60,000 to 80,000 and 100,000 pounds."

AXLES FOR HEAVY CARS.

The present tendency toward the use of cars of capacities greater than 80,000 pounds renders it advisable that the Master Car Builders' Association should take steps toward the establishment of a standard axle which shall have greater carrying capacity than the heaviest which has so far received the attention of the association, viz., the 80,000-pound axle, and the subject was introduced by Mr. E. D. Nelson at the 1898 convention in a letter, which we think important enough to reproduce nearly in full, as follows:

The Committee on Subjects for 1898 included in their report a topical discussion of the question of an axle for 100,000 pounds capacity cars, and a revision of the axle for 60,000 pounds capacity cars. In regard to the axle for cars of 100,000 pounds capacity there are now being built by one railroad company of which I have knowledge 1,000 cars of 100,000 pounds capacity, and I think that there is one other railroad which has in use about an equivalent number of cars of this same capacity. It has occurred to me that it would be well for the Master Car Builders' Association, as early as possible, to settle upon a design for an axle for these cars. I have therefore taken the liberty of designing an axle for a 100,000 pounds capacity car. In designing the axle for a car of 100,000 pounds capacity the method outlined in the report of the Committee on Axle, Jour-

nal Box Bearing and Wedge for cars of 80,000 pounds capacity, made to the convention of 1896, has been followed:

The data are as follows:

Weight of body and trucks		40,200 lbs.
Weight of lading		100,000 lbs.
20 per cent. additional lading		20,000 lbs.
Total		160,200 lbs.
Deduct weight of eight 33-in. wheels	5,000 lbs.	
Weight of four axles	3,200 lbs.	
Total		8,200 lbs.
Total weight on four axles		152,000 lbs.
Static load on one axle		38,000 lbs.

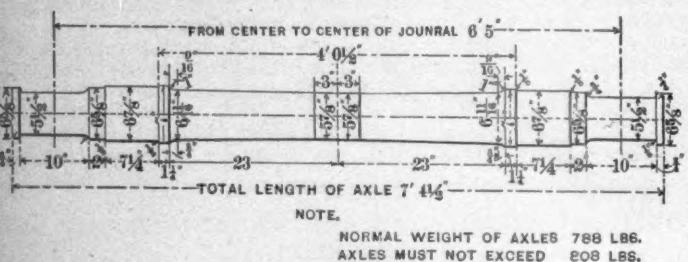
In order to find the point at which the load must be considered as acting on the journals it is first necessary to consider the dimensions of the latter:

The Master Car Builders' journal for 40,000-pound cars is 7 inches long, for 60,000-pound cars 8 inches long, for 80,000-pound cars 9 inches long. It might, therefore, be assumed that for cars of 100,000 pounds capacity the journal should be 10 inches long.

We can suppose, for the purpose of maximum conditions of wear, that the collar of the journal should be worn off ½ inch in thickness from contact with the bearing, and the bearing worn off ¾ inch on the end next to the collar. The journal would then be 10½ inches long, and the bearing surface on the journal would be 8¼ inches long. This would throw the center of bearing surface 1⅜ inches outside of the normal center line of journal.

Referring to Fig. 6, page 167 of the Proceedings of 1896, the lever arm T would be, therefore, equal to 6⅜ inches; and assuming this lever arm ½ inch greater on account of the dust guard seat being reduced ½ inch in length, it would make the value of T 6⅞ inches.

By substituting in formula 12, page 153, and calculating the



Axle for 100,000 Lbs. Capacity Cars.

moment from the above dimensions, we find the diameter of the journal to be 4.98 inches. Taking the nearest eighth of an inch above this theoretical diameter would make the journal 5 inches; and allowing ½ inch for wear would make it 5½ inches.

Assuming the journal, therefore, to be 5½ by 10 inches, it is found that, so far as friction and lubrication are concerned, we have the following data, in connection with page 169 of the Proceedings of 1896:

4¼ x 8 journal, new; pressure per square inch	449 lbs.
5 x 9 journal, new; pressure per square inch	469 lbs.
5½ x 10 journal, new, pressure per square inch	470 lbs.
4¼ x 8 journal, worn to limit of 3¾ in.	533 lbs.
5 x 9 journal, worn to limit of 4½ in.	525 lbs.
5½ x 10 journal; worn to limit of 5 in.	516 lbs.

These figures would indicate that the size of journal from the standpoint of friction and lubrication is all that need be desired.

It is now only necessary to arrive at the design of axle between wheels, and, assuming the point of concentration of load the same as that selected above for calculating the diameter of the journal, and applying the figures for weight as previously assumed, the theoretical diameters of the vital points of the axle between the wheels are as follows:

Wheel seat, 6.70 inch.

Center, 5.73 inch.

Taking the nearest eighth of an inch above these figures, and allowing ⅛ inch on wheel seat for reduction of same, we have for diameter of wheel seat 6⅞ inches, and for center 5⅞ inches.

The nearest eighth of an inch above the theoretical diameter at center given above would actually be 5¾ inches; but by making the center of the axles straight for 6 inches, which is considered desirable, it is necessary to increase this diameter in order that the straight portion of the axle at the center may not intersect the tapered portion at a point whic would give a diameter less for that particular point than the theoretical diameter.

The assumptions for fiber stress have been taken at 22,000 pounds per square inch for that portion of the axle between the wheels, and 10,000 pounds per square inch for strength of journal; and the actual fiber stress based on the dimensions given above is safely within these limits.

In regard to the revision of design of axle for 60,000 pounds capacity cars, it will be noted on page 183 of the Proceedings of 1896, that the Master Car Builders' axle, with 4¼ by 8 inch journals, has a fiber stress at the hub, when reduced 1-16 inch in diameter, of 24,030 pounds; at the center of 22,452 pounds; and it was with the idea of making this axle somewhat larger at the hub and slightly larger at the center that we suggested that the present design be revised. This would not involve any changes affecting the interchangeability of these axles in freight cars.

BENDING TESTS OF LOCOMOTIVE STAY-BOLTS.*

By Francis J. Cole.

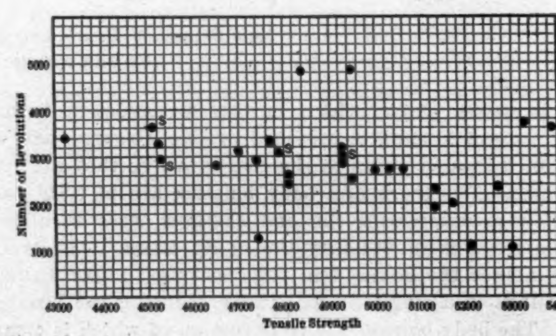
No parts of a locomotive require so careful and systematic inspection, to maintain them in a safe working condition, as the stay-bolts.

Speaking generally, their life, that is, the interval which elapses from the time the boiler was new or the stay renewed to their fracture, varies from about one to five years or longer. Probably the average would not exceed five years on all classes of engines. This depends, however, upon the length and height of fire-box, steam pressure, size of boiler, width of grate, etc.

The stay-bolts in a boiler of large diameter, with the firebox between the frames and small curves or radii connecting the circular portion with the vertical sheets of the fire-box shell, may always be expected to have a shorter life than in a boiler of the same length of grate, but of small diameter, with the fire-box on top of the frames.

As modern requirements demand large boilers, high steam pressures, long fire-boxes, etc., in short, the very conditions which ought not to exist if the stay-bolt alone were considered, their life may reasonably be expected to be shorter than in the past, owing to the construction necessary for heavier, more powerful and economical engines.

The stress on a stay-bolt produced directly by the steam pressure, tending to force the two sheets apart, is a comparatively small factor in causing its fracture, the tensile stress alone being only ⅛ to 1-10 of the ultimate strength, which, if not complicated by the expansion and contraction of the firebox, causing bending in addition, would in itself never produce a fracture. It follows, then, that the property of a metal to



resist repeated bendings is more valuable than its strength to resist extension or fracture in the direction of its length.

Following out this general idea that stay-bolt iron should be tested for bending under uniform conditions of motion and rigidity with the usual tests for ultimate strength, elongation and elastic limit, a number of different makes of iron were tested on a machine especially designed for the purpose. These tests were made by the writer about three years ago.

In designing the machine two features were kept prominently in view; viz., to make the machine rigid and to clamp the specimen so tightly that no motion would take place in the fixed end, and at the same time to strain it by tension in imitation of the stress produced by the steam pressure.

Its construction is so clearly shown in the drawing that an extended description will be unnecessary.

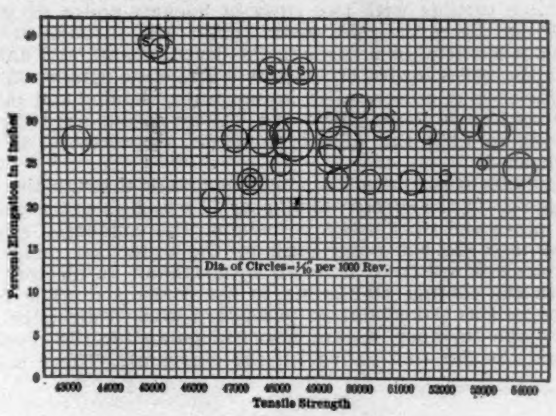
Although the machine is arranged to test pieces 3, 6 and 9 inches in length, the tests were all made with a uniform length of 6 inches, measured from the center of the bolt to the face of the hardened steel die, on account of the difficulty experienced in obtaining any reliable spring pressure with the bolt shorter than 6 inches. The liner used in the machine for all specimens was 1-16-inch thick, making the free end of the stay-bolt describe a circle ⅛-inch in diameter. Great care

*From a paper read at the Niagara Falls meeting (June, 1898) of the American Society of Mechanical Engineers.

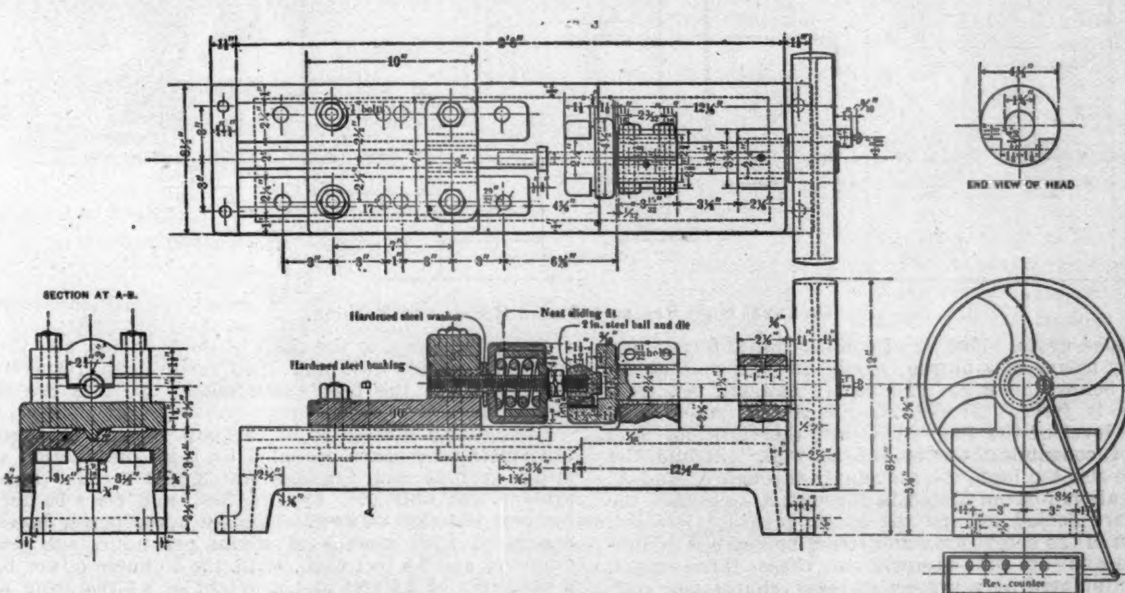
was taken to clamp the bolt so securely in the machine that the movement of the projecting end was scarcely appreciable.

The spring pressure used in all cases was 2,400 pounds, corresponding to the strain exerted by the steam pressure in a boiler where the stay-bolts are spaced 4 inches center to center, with a steam pressure of 150 pounds per square inch.

It is clearly shown, I think, by these tests, that the principle of the machine is correct, and that the solid durable manner in which it is designed eliminates most of the variables which have hitherto made these bending tests of but little value. The average general results which the different



qualities of iron gave, followed closely the quality and value of iron for actual service. The imitation by the machine of the strains produced in a stay-bolt, when screwed in a boiler, is very close, and while some of the tests of the same bar show a larger percentage of difference than in the tensile tests of the iron, yet this is probably accounted for by the fact that in case the threads were cut sharper, or any flaw existed in the iron, its effect would be very much more marked and exag-



Machine for Testing Staybolts.

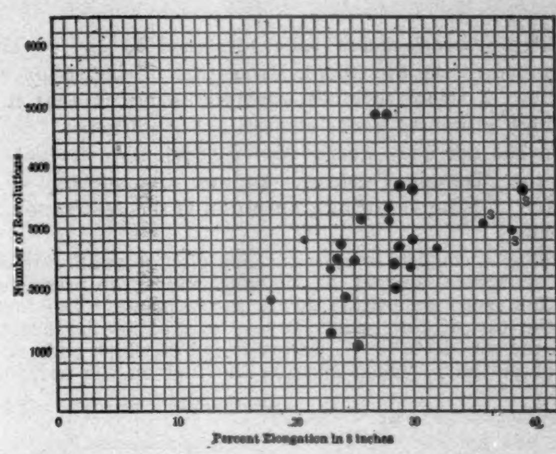
gerated than would be shown by an ordinary tensile test. While the individual tests of specimens cut from the same bar are somewhat erratic in a few instances, yet the average of the tests cut from the same bar seems to follow some well defined law.

Cutting off the threads and reducing the size of the middle of the specimen does not in these tests indicate a sufficient degree of improvement in prolonging the life of the stay-bolt to warrant the extra expense. It appears that after a bolt is reduced and turned down a sufficient amount to equalize the strain, and to distribute it over a considerable portion of its free length, the stress produced by the pressure of the spring runs up to such an extent, per square inch of section, that the combination of bending and extension stresses exercises a marked influence in shortening the life of the bolt.

The table given below indicates for a uniform pressure of 2,400 pounds, the stress per square inch of section on the different diameters of reduced bolts:

Size. inch.	Area.	Stress, pounds.
1	.7854	3,050
15/16	.6903	3,475
7/8	.6013	3,990
13/16	.5185	4,630
3/4	.4418	5,430
11/16	.3712	6,465
5/8	.3068	7,820
9/16	.2485	9,658
1/2	.1963	12,226

After experimenting with the 7/8-inch bolt reduced to the different diameters, it seemed plausible that by increasing the



diameter to 1 inch, and then reducing the section, that a marked improvement might be made. This, however, did not seem to prolong the life to any great extent.

The approximate cost of renewing stay-bolts, a few at a time, is as follows:

Cutting out one broken 7/8-inch stay-bolt, re-tapping holes, and putting in new bolt	18 cents.
Riveting up two ends	2 "
Total cost of renewing stay-bolt	20 cents.

This does not include taking down or putting up any parts of machinery which may be in the way of renewing the stay-bolt. In round figures the minimum cost for labor for renewing stay-bolts in small numbers would be 15 cents per pound. This is for the simplest cases; if there is any machinery or part to be removed, the cost would be greatly increased. Inasmuch as the cost of labor alone for renewals is nearly three times the cost of the highest-priced stay-bolt iron, it would be economical to use a special stay-bolt iron possessing the necessary properties to resist repeated bendings.

The results of the tests are plotted in the diagrams. A careful study of these show that the best results were obtained from an iron having an ultimate strength of 48,000 to 49,500 pounds, with an elongation of 28 to 30 per cent. in 8 inches.

If it were possible to make the stay-bolts of sufficient length to allow for the maximum movement of the fire-box, so

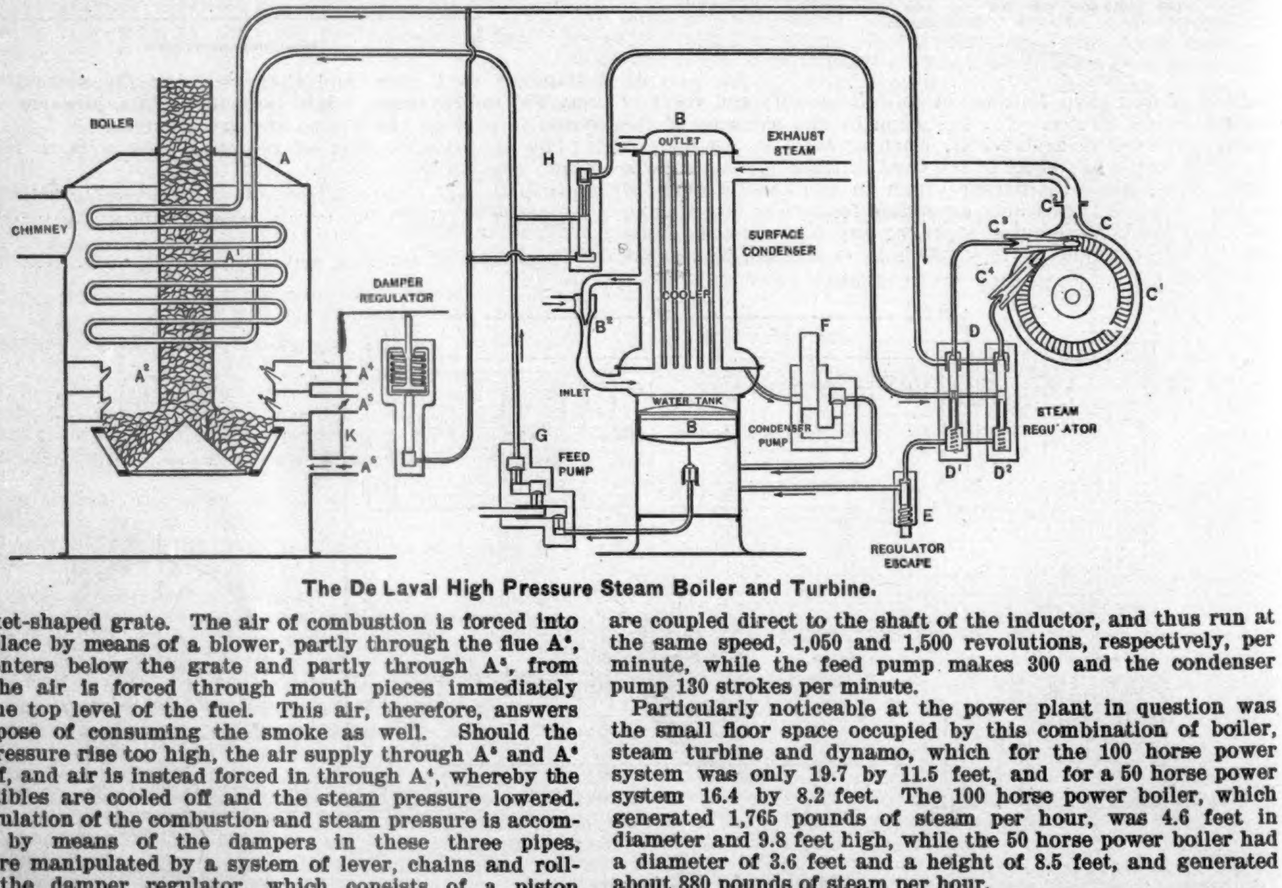
as to bend them within their elastic limit, without producing a permament set, their life would be increased to a remarkable extent.

Let X represent this movement at a distance Y, it is evident, then, that if the length, Y, is decreased, the bending movement will be increased so that fracture will occur with a smaller number of movements. With a constant amount of movement, the decrease of length can so intensify the bendings stress that fracture will occur after a few thousand repetitions of the force, produced by the expansion and contraction of the boiler.

THE DE LAVAL HIGH-PRESSURE STEAM BOILER AND TURBINE.

The high-pressure steam boiler designed by Dr. de Laval and installed at the Stockholm Exposition in connection with the exhibit of steam turbines was interesting, in that it involved high pressures under commercial conditions. The application has not been clearly shown previous to its publication in the "Ternisk Tidskrift," and we are indebted to the "Iron Age" for the following translation of the description and the drawing.

The boiler A consists of a single long pipe of small diameter, bent in cylindrical spirals, A^1, between which the products of combustion pass, generating steam in the same. The fuel is fed at the top of the boiler, and is carried to the fireplace through the central tube A^2, the lower end of which ends above a cone of masonry, which spreads the fuel on the surrounding basket-shaped grate. The air of combustion is forced into the fireplace by means of a blower, partly through the flue A^3, which enters below the grate and partly through A^5, from which the air is forced through mouth pieces immediately above the top level of the fuel. This air, therefore, answers the purpose of consuming the smoke as well. Should the steam pressure rise too high, the air supply through A^5 and A^6 is cut off, and air is instead forced in through A^4, whereby the combustibles are cooled off and the steam pressure lowered. This regulation of the combustion and steam pressure is accomplished by means of the dampers in these three pipes, which are manipulated by a system of lever, chains and rollers in the damper regulator, which consists of a piston the steam pressure on which is counterbalanced by a spring. As soon as the steam pressure changes, the piston moves in one direction or another, and thus opens or closes said dampers. The water is fed to the boiler by the feed pump G, which has several plungers (four in the 50 horse power system, and six in the 100 horse power system), in order to furnish as even a supply of water to the boiler as possible. The suction pipe of the pump is connected with the water cistern, where the supply is regulated through the float, and which, thus, by the water level, determines the amount of feed water to the boiler.



The De Laval High Pressure Steam Boiler and Turbine.

The steam generated in the spiral pipe at the exhibition plant had a temperature of 660 degrees F., and a pressure of 1,735 pounds, which at the steam turbine was reduced to 1,420 pounds per square inch. The steam is first conducted to the regulators D, which successively adjust the amount to the nozzles C^3 and C^4 of the turbine C. This regulation is accomplished by hydraulic pressure in the following manner: The pressure water is obtained from the discharge pipe of the feed pump to the boiler and passes a reducer, H, which reduces the pressure to that of the steam. From here it goes to the middle part of the steam regulators and drops around the piston down to the lower ends D^1 and D^2, where the pressure of the water and the spiral springs is counterbalancing the steam pressure in the upper ends of the regulators. The pressure of the water in the lower ends of the steam regulators is determined by the regulator escape E, which is opened and closed by a centrifugal regulator.

From the upper ends of the steam regulators the steam is conducted through four mouth pieces, or tuyeres, C^3 and C^4, with very small apertures. The turbine disk C^1 is constructed as a double turbine with two rows of buckets and a division wall. From the tuyeres the steam passes first through one of the rows of buckets, then through the division wall, and finally through the other series of buckets. The disk rotates 13,000 revolutions per minute in a 100 horse power turbine, and 16,400 revolutions in a 50 horse power one. These speeds are reduced by gearing to 1,050 and 1,500 revolutions, respectively, at the indicator shaft.

The exhaust steam from the turbines passes through the exhaust pipe C^2 to the surface condenser B, which is composed of vertical pipes and works with a vacuum. The condensed steam is forced into the hot water tank by the condenser pump F. The condensers are freed from air by means of an ejector, B^2, placed in the cooling pipe going to the condenser. The feed pump, as well as the condenser pump, are worked direct or indirect by the turbines, as are also the pump for the cooling water and the fan (not shown on the diagram). These latter are coupled direct to the shaft of the inductor, and thus run at the same speed, 1,050 and 1,500 revolutions, respectively, per minute, while the feed pump makes 300 and the condenser pump 130 strokes per minute.

Particularly noticeable at the power plant in question was the small floor space occupied by this combination of boiler, steam turbine and dynamo, which for the 100 horse power system was only 19.7 by 11.5 feet, and for a 50 horse power system 16.4 by 8.2 feet. The 100 horse power boiler, which generated 1,765 pounds of steam per hour, was 4.6 feet in diameter and 9.8 feet high, while the 50 horse power boiler had a diameter of 3.6 feet and a height of 8.5 feet, and generated about 880 pounds of steam per hour.

Regarding the danger of explosion of the boiler under such enormously high pressure as used for obtaining this improved effect of the steam in the turbines, this is here reduced to a minimum by the exceedingly small diameter of the spiral pipe and consequent small volume of steam it contains, besides the absence of any large volume of water. The water as it enters the spiral is immediately converted into steam, and if the pipe should burst somewhere the steam in that part of the pipe would instantly escape, and so also, successively, the steam from the other parts of the boiler, until the whole contents has passed out through the chimney. Besides, these pipes are made of the very best material, drawn and hammered out from whole ingots and afterwards cold pressed and tested under a pressure several times that expected to be carried.

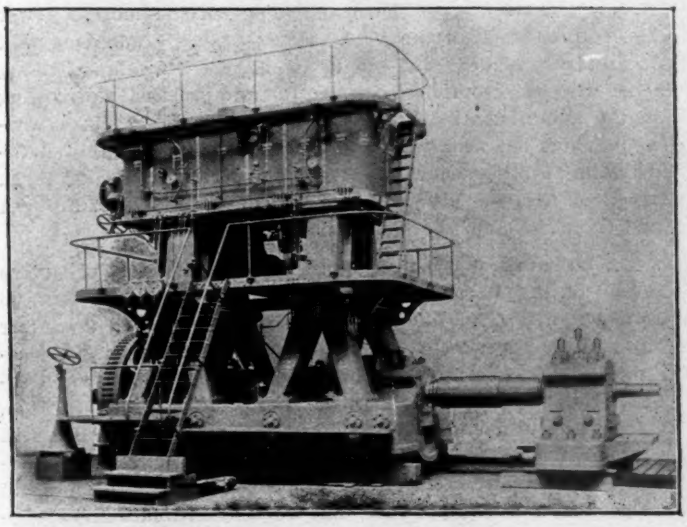
Experimentally, the pipes have been made to explode "directly in view of the operator" without causing any damage whatever.

WESTINGHOUSE ENGINES AND GENERATORS.

At the invitation of the Westinghouse Machine Company and the Westinghouse Electric and Manufacturing Company about 300 engineers enjoyed an instructive visit to the works of these celebrated builders at Pittsburg, Pa. The works are always interesting, but specially so now on account of the machinery that is nearly completed for shipment abroad, the large gas engine and the new Parsons steam turbine, all of which were exhibited to the visitors.

The machinery for the Metropolitan Electric Supply Company of London includes three 2,500 horse power engines, the largest built by this firm, and direct connected generators, each having a nominal output of 2,000 horse power with 500 volt two-phase current. This is a noteworthy order, and the appearance of the work justifies the expectation that more American machinery will follow this to the other side of the water. The engines and generators are mounted on separate bed plates and the exciters are connected direct to the engine shafts.

The engines are the largest of their type ever built. They



Westinghouse Engines for the Metropolitan Electric Supply Company, London, England.

are compounds, with cylinders 36 and 55 by 36 inches and are of the inclosed vertical marine type. The steam pressure may be as high as 200 pounds, though they are designed to give the best results at a pressure of 140 pounds and a speed of 120 revolutions per minute. When exhausting into the atmosphere at 133 revolutions per minute and under 100 pounds pressure the engines develop 2,500 horse power, while at 120 revolutions and 140 pounds pressure they will develop 3,500 horse power at a maximum. The bed plates are of the box form for mounting upon concrete foundations. The crank shaft is extended at one end to an outboard bearing to provide for the generator. The crank shaft is of forged steel, 14 inches in diameter, and it is enlarged at the armature to 20 inches. The piston rods are 8 inches in diameter. The weight of the outboard bearing is about 20,000 pounds, while the combined weight of one generating set is about 435 tons, the engine weighing about 210 tons. The engine is about 20 feet high. The lubrication is carefully attended to and so is the adjustment of the main bearings to take up wear. These bearings are in four adjustable sections, the lower one being cased for cooling water. The main bearings are 28 inches long, and throughout the design it is made evident that the engines are to be run for long periods without stopping. Piston valves are used, that for the high-pressure cylinder being double ported and the pair for the low-pressure cylinder being single ported.

The generators were not mounted at the time of the visit, but before we go to press one complete unit will be shipped to London, to be followed within a few weeks by the rest of the order. The fields have 62 pole pieces of laminated steel plates, the frame being in two parts split vertically, so as to be separated along the axis of the generator for easy access to the armature. The field coil winding is on copper strips placed on edge. For ease in shipment and in handling, the armature spider was cast in halves. The armature winding is in rectangular copper bars in the slots of the punched armature rings, and the ventilation of the armature is excellent. The direct current exciters are mounted on the ends of the armature shafts outside of the outbound bearings.

Among the large orders for electrical machinery were 15 complete units, including a 5,000 horse power alternating generator for each, to be erected in the plant of the St. Lawrence Power Company, at Messena, N. Y.

At the works of the machine company a 200 horse power Parsons steam turbine was running at a speed of 4,800 revolutions, direct connected to a 200 horse power generator giving a current of 900 volts and 75 amperes. The current was used for running shop motors, and also for lighting. This is the first steam turbine of this type built in this country, and its smoothness of running was impressive. We recorded the success of this motor on the "Turbinia" on page 46 of our issue of February, and on page 187 of our issue of June, 1897.

The Westinghouse gas engine was described and illustrated in our issue of September, 1897, page 302, and at that time it was stated that a 750 horse power gas engine was under construction at these works. This was an error, the horse power being 650, and the engine referred to was seen running in connection with a prony brake. This is the largest gas engine unit ever constructed, and there seems to be every reason to believe that it is a complete success. It has three cylinders, each 25 inches in diameter with a 30-inch stroke, and runs at 145 revolutions per minute. For the principles upon which it is constructed and governed, we refer the reader to our previous description, and repeat that these engines are governed by the amount of explosive mixture of gas and air drawn into the cylinder at each stroke, instead of by the common "hit and miss" principle. The governing is said to be entirely satisfactory when this large engine was coupled direct to a generator, for which purpose it was built. We are told that the gas used is mixed with about 12 parts of air and that the consumption, under very favorable conditions, has been 11 cubic feet of natural gas per brake horse power.

The steadiness of operation of the smaller gas engines was demonstrated by the lights from a 65 horse power direct connected engine, which showed no fluctuations, and this indicates perfectly satisfactory governing. It will be remembered that each of these engines is equipped with a small air compressor to be used to compress air into a receiver for starting the engine.

The visit was thoroughly enjoyed, and the visitors were impressed by the character and splendid quality of the work seen.

The disadvantages of compartment cars with no means of intercommunication are shown in a ludicrous light in the following, which is quoted from "Transport:" "The Western Railway of France has adopted a most unique method for assisting passengers who leave their carriage in order to snatch a mouthful of refreshment on a long journay, to find their seats again. It is indeed quite an educational idea. On their express morning train from Paris to St. Malo and Parame they have put carriages on with pictures painted inside. One has an elephant, another a lion, another a snake, yet a fourth a lyre, while others have anchors, huntsmen's horns, tri-colored flags, balloons, grapes, swallows, pair of scales, a star, a fishing-rod, painted on the doors. These signs, the directors believe, will be more easily remembered than mere numbers."

PERSONALS.

Mr. H. A. Bowen has resigned the position of Master Car Builder of Swift's Refrigerator Transportation Company.

Mr. John Hawthorne has been appointed Master Mechanic of the Lehigh Valley at Sayre, Pa., to succeed Mr. J. N. Weaver.

Mr. F. O. Emerson has been appointed Master Mechanic of the Louisiana & Northwest, with headquarters at Gibsland, La.

Mr. William Rees has been appointed General Master Mechanic of the Interoceanic Railway; headquarters at Puebla, Mexico.

Mr. S. C. Boutelle, Master Mechanic of the San Diego, Pacific Beach & La Jolla Railway at San Diego, Cal., has resigned on account of ill health.

Mr. H. Tandy, Superintendent of the Brooks Locomotive Works, has resigned to accept the Superintendency of the Canadian Locomotive Works at Kingston, Ont.

Mr. Frank Johnson has been appointed Master Mechanic of the Mahoning Division of the Erie Railroad, with headquarters at Youngstown, O., in place of Mr. Willard Kells, promoted.

Mr. Paul Synnestvedt, formerly with the Crane Company in Chicago, has opened an office in the Monadnock Building in that city, and will give his entire attention to patent law business.

Mr. Arthur S. Bosworth has resigned as Purchasing Agent of the Maine Central, and is succeeded by Mr. Charles D. Barrows, formerly Assistant Purchasing Agent. Headquarters, Portland, Me.

Mr. Ferdinand W. Peck of Chicago has been appointed by President McKinley to succeed the late Moses P. Handy as Commissioner General of the United States for the Paris Exposition of 1900.

Mr. Thomas T. Johnston, of Evanston, who has been known for his good work at Assistant Chief Engineer of the Sanitary District of Chicago, has been promoted to the position of Consulting Engineer.

Mr. J. E. Gould, formerly Assistant Master Mechanic of the Pennsylvania lines at Dennison, O., has been appointed Master Mechanic of the Toledo & Ohio Central shops at Columbus, O., to take effect Sept. 1.

Mr. E. W. Knapp was on July 12 appointed Master Mechanic of the Michoacan & Pacific, in charge of the motive power department, with headquarters at Zitacuaro, Mex., vice Mr. W. H. Rice, resigned.

Mr. A. M. Parent has been appointed Manager of the Works of Pullman's Palace Car Company at Pullman, Ill., and the authority of Mr. Frederick Wild, Assistant Manager, has been extended over all departments.

Mr. G. Wirt has been appointed Master Mechanic of the Big Four-Chesapeake and Ohio and Louisville and Jeffersonville Bridge Company, vice W. A. Bell resigned. Mr. Wirt was formerly General Foreman of the Big Four at Wabash.

Mr. Willard Kells, heretofore Master Mechanic of the Mahoning Division of the Erie Railroad, has been appointed Master Mechanic of the Chicago & Erie, with headquarters at Huntington, Ind., in place of Mr. J. Hawthorne, resigned.

Mr. Cornelius Shields has been elected to the Vice-Presidency of the Spokane Falls & Northern, in charge of the operation of the road, with headquarters at Seattle, Wash. Mr. Shields has also been chosen President of the Columbia & Red Mountain, which is a part of the Spokane Falls & Northern system.

Mr. A. L. Studer, heretofore Master Mechanic of the Southwestern Division of the Chicago, Rock Island & Pacific at Trenton, Mo., has been appointed Master Mechanic of the Illinois Division, with headquarters at Chicago, in place of Mr. John Gill, who is now Master Mechanic of the Southwestern Division at Trenton.

Mr. W. W. Peabody, who has been Vice-President and General Manager of the Baltimore & Ohio Southwestern, has been relieved of the responsibility of the operation, which has been given to Mr. I. G. Rawn as General Manager. Mr. Rawn has been General Superintendent of the road for a number of years. Mr. Peabody has been Vice-President since January, 1890, and General Manager since November, 1893. Mr. Rawn was appointed General Superintendent of the Baltimore & Ohio Southwestern in January, 1890. He was formerly Master of Transportation of the Kentucky Central and was for one year with the Chesapeake & Ohio as Division Superintendent and Superintendent of Transportation.

Mr. William Forsyth has been appointed Superintendent of Motive Power of the Northern Pacific Railway to succeed Mr. E. M. Herr. Mr. Forsyth began railroad work on the Philadelphia & Reading and was afterward connected with the Pennsylvania, and he is best known as Mechanical Engineer of the Chicago, Burlington & Quincy Railroad, the position he now resigns and has held for a number of years. He has been closely identified with the development of the motive power and rolling stock of the road. Being a keen student as well as an accomplished engineer, he is one of the foremost among those who have combined engineering and practical railroading in the administration of motive power matters. His experience, which has been wide and thorough, has admirably qualified him to fill his new position. The Northern Pacific is an excellent field for his work and we congratulate Mr. Forsyth and the road upon the appointment.

Mr. Edwin M. Herr has resigned as Superintendent of Motive Power of the Northern Pacific to become Assistant General Manager of the Westinghouse Air Brake Company. Mr. Herr has had an unusually wide experience. He started as a messenger boy for the Western Union Telegraph Company, and entered railroad work on the Kansas Pacific Railroad in 1878, since which time he has been busy with promotions, but still has had time to secure a good technical education. He has devoted most of his attention to the mechanical department, and is specially well equipped for that work by intimate knowledge of operating matters obtained when he was Superintendent of Telegraph and Division Superintendent on the Burlington. The higher positions which he has held in mechanical departments are Master Mechanic of the Chicago, Milwaukee & St. Paul, Superintendent of the Grant Locomotive Works and Assistant Superintendent of Motive Power of the Chicago & Northwestern. By this change the railroad service loses one of its best men, and the Westinghouse Air Brake Company acquires one whose qualifications are altogether exceptional.

THE PRESENT FORM VERTICAL PLANE COUPLER—DOES IT MEET ALL REQUIREMENTS?—HAS IT COME TO STAY?

By Pulaski Leeds.

In a paper by Mr. Pulaski Leeds, Superintendent of Machinery, Louisville & Nashville R. R., read before the Central Association of Railroad Officers, the faults of the present types of M. C. B. coupler are outlined in a forcible way. We cannot answer the question: "What are we going to do about it?" but commend the suggestion from Mr. A. M. Wait printed on page 256 of our August issue in this connection. Mr. Leeds said:

A concise statement of my opinion would be an emphatic negative to the first question; and an equally emphatic affirmative to the last, and "What are you going to do about it?" It seems to me scarcely credible (or creditable) that the adoption of this device should have resulted from a careful investigation and consideration of the conditions and requirements of service; first, that the concussion should be evenly and squarely met on a central line; second, that the pulling strain should be on a central line to avoid all tendency to crowd the flanges against the rail; third, that the connection should be so flexible that there should be no unnecessary friction at any time, or difficulty in coupling on any practicable curve; fourth, that the device should be capable of having its strength increased to meet future requirements of heavier motive power; fifth, that it

should be always operative; sixth, that there should be as great a uniformity as there was in the link and pin.

In my opinion the present style of vertical-plane coupler contains none of these essentials. When cars are thrown together the greater part of the blows are received at the point of greatest adverse leverage, far outside the center line of the column. In pulling, the line of strain is considerably out of center. The connection is not as flexible as it should be, as for obvious reasons the bar must not have any great amount of lateral movement; hence, where there is an appreciable difference in the overhang of two cars, as in the case of a car with a six-wheeled truck coupled to one with a four-wheel, there is a great leverage tending to crowd the car with the shorter overhang off the track. Not only has this been demonstrated by the derailing of tenders where this rigid connection has been made, but it can be easily demonstrated by diagraming a four-wheeled baggage express car, built without platforms, and a six-wheel car with such platforms. The centers of the couplers will be several inches out of line with each other, and it has been demonstrated that in order to force them into line a transverse pressure of upward of 50,000 pounds has to be exerted. While these are exceptional cases, the same holds good in degree throughout our whole equipment, and taken in connection with the "demnition grind," both vertical and horizontal, caused by the motion of the cars and a rigid sliding bearing, as against the pivoted action of the link and pin, not only causes our trains to pull harder, but is destructive to both equipment and track.

This device was adopted when the car equipment and motive power were a great deal lighter than now, and the lines that were adopted were those that had been produced to meet the requirements of that time and in competition commercially with the link and pin, and as those lines were such as precluded the possibility of increasing the proportions, the only increase in strength lies entirely in the quality of the material used, and the temptation to consider first cost is so strong as to, in a great measure, defeat this measure; in fact, this point of first cost is so strong that there are couplers in which the weight has been reduced from the original construction, enabling the manufacturer to reduce the price per car while getting practically the same price per pound.

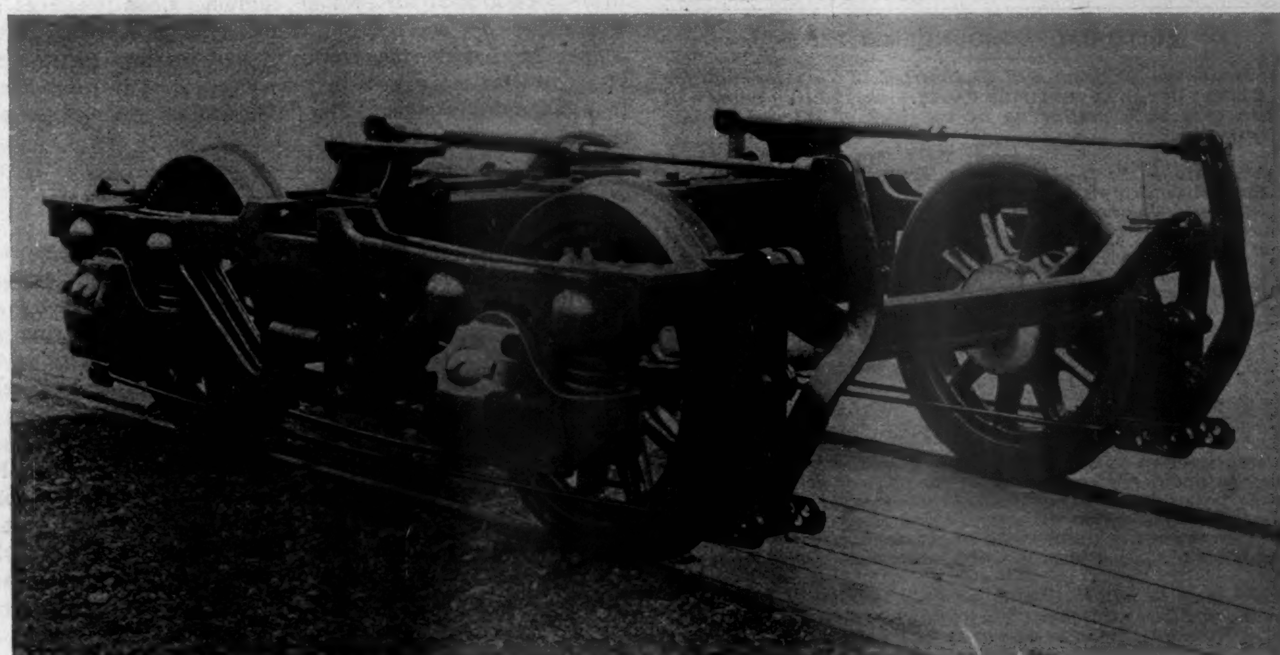
As to the unlocking devices being at all times operative, it can be safely said that any coupler which can be fairly criticised upon fixed mechanical principles as likely to give trouble at a given point will, after a certain amount of strain and wear in service, surely prove troublesome at the point thus criticised. This criticism can fairly be made upon most all couplers in service to-day; thus any coupler of a design likely to break or get out of order readily, to couple with great difficulty under some of the ordinary conditions of service, to come uncoupled, or not to uncouple when required, is faulty, and such defects are more likely to develop when all cars are equipped with the M. C. B. couplers.

While it is incumbent upon us to so construct our draft rigging as to render the danger of bars pulling out as small as possible, still it is a fact that they do so, and also that bars break, in which case we lose the old safeguard of the link and pin holding the head or bar up until the train is stopped; hence there has been an element of great danger introduced, and which no effective device, so far as I know, has been provided to meet.

But allowing that there are some who agree with me, please answer the query, "What are we going to do about it?" The great number already applied, and the fact that within a short period all cars must couple automatically by impact, make it the standard of the country; and further, the fact that all couplers of the future must couple with this type prevents not only the introduction of any other type, but any improvements in this type as to the essential of strength. As I have heretofore remarked, these outlines were designed to meet the requirements of a service when the heaviest motive power was such as is now being retired from service as being too light for economical operation, and while the ultimate tensile strength of the bar may still meet the requirements of the increased motive power, still the most destructive agency has been increased in the same proportion, i. e., the blows received in yards from moving cars of from 90,000 pounds gross weight, as against those of about 50,000, the velocity being a variable and unknown quantity, but probably not decreased, yet with all its faults we have still, and, with the immense sums expended upon it, we are likely to have it for many years to come; therefore the only thing we can do is to try and make it the most effective, serviceable, economical and least dangerous possible.

THE HEDLEY MOTOR CAR TRUCK.

To provide for the heavier motors required under the cars of the Lake Street Elevated Railway, Chicago, Mr. Frank Hedley, General Superintendent of the road, designed the truck, which is shown in the accompanying engraving. The trucks were built by the Siemens & Halske Electric Co., and they are reported to be entirely satisfactory.



Hedley's Motor Car Truck—Lake Street "L" Railway, Chicago.

The side frames are of cast steel, including the pedestal jaws, and the outline is in general that of the diamond-frame truck, with pedestal tie bars attached to the side frames by bolts. The transoms, which are in the form of deep steel plates, are also attached by bolts. The truck bolster is carried by links 21 inches long for the purpose of giving an easy side motion, and together with the arrangement of the springs, this feature results in very easy motion. One of the objects of the design being to give room for two G. E. 55 motors of 175 horse-power each, it was necessary to avoid the use of brake beams, and the illustration shows very clearly how this was accomplished by the aid of brake rods inside and outside of the wheels. The cross-tie bars at the end of the truck frames, which are of T section, are offset downward to clear the draft gear. The weight on each journal is about 7,000 pounds and the amount of clearance under the motor casings from the ties is 3 inches. The wheels are 33 inches in diameter and the wheel base is 6 feet.

A promising experiment with a Leach sander is now being tried on one of the trucks, whereby sand may be delivered under all four wheels. Hose connections are used between the motorman's cab and the sanders. We are informed that by using sand a train may be accelerated to a speed of 24 miles an hour in 16 seconds, which is exactly one-half the time required for the same speed without sand.

(Established 1832)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

29TH YEAR. 67TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING..NEW YORK

G. M. BASFORD, Editor.

SEPTEMBER, 1898.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

The "Battle of the Gages" seems to be "on" again in discussions of the Institution of Mechanical Engineers of England. There seems to be an extraordinary vitality to the idea that narrow gage roads are much cheaper than standard to build, and we direct the attention of those who believe this to the article on the "Relative Cost of Narrow and Standard Gage Railroads," by Mr. M. N. Forney, on page 369 of our issue of November, 1897.

There is nothing more difficult about the administration of a shop plant than piecework. Those who have settled upon a satisfactory plan find that very soon new conditions arise which make it necessary to change the prices, no matter how well adjusted they may have been originally. The greatest trouble, however, is found at the outset in fixing the rates for the first piecework schedule, and this is the key to the whole subject. We are told that the method adopted in the Rugby Works of Messrs. Willans & Robinson was to establish prices slightly higher than those for day work, and to divide the difference between the piece work and the day work wages evenly between the works and the men. By this system the men have every inducement to earn all they can, and the benefit to the works is direct, and is clearly understood by the men.

In describing the works of the Midland Railway of England on the occasion of the recent visit of the Institution of Mechanical Engineers, "The Engineer" (London) said: "We were somewhat disappointed to see so few really modern machine tools in the workshops, and felt that surely considerable saving in cost of production could be effected by the addition of machines of more recent type." This should be food for thought for a great many high railroad officers in this country also.

The effect of segregation on the wearing qualities of bearing metals is so little understood that we are glad to give our readers the benefit of the experience of Mr. Guilliam H. Clamer, in his paper before the Franklin Institute on the "Microstructure of Bearing Metals," a reprint of which is to be found elsewhere in this issue. The value of bearing metals depends not alone upon the metals that are used to form the alloy, but also upon the structure of the product, and it is not at all unlikely that the microscope will be called upon generally to assist in future tests of bearing metals. Mr. Clamer believes the micro test to be even more important than chemical analysis, and by following the account of his work there appears to be good ground for such an opinion. Good judgment and wide experience are required in using the microscope in this connection, but the importance of cool bearings in train service calls for more care in the selection of bearing metals than is generally given. This is a good subject for the most careful scientific examination.

SIDE BEARINGS FOR CARS.

Shall the load of freight cars be carried upon the center plates alone or upon the center plates and the side bearings? This live question grows out of the increasing capacity and weight of cars. The original object of the side bearing was not to support the load under ordinary running conditions, but to prevent excessive tipping or rocking of the car in passing curves; in the future, however, it may be called upon to do much more than this.

We should say that the load should not be allowed to rest permanently upon the side bearings unless a satisfactory roller or "anti-friction" bearing is used, and many look askance at the roller bearings when applied under such peculiarly trying conditions, but if they can be made satisfactory they present an ideal arrangement, as Mr. Waitt has pointed out. The great waste of locomotive power which is caused by the trucks being held askew by ordinary side bearings that are in contact has already been commented upon in our pages and a reasonable conclusion seems to be that the car structure, when ordinary side bearings are used, should be made so strong that the side bearings will never come into contact except when they are needed to prevent the tipping or oscillation of the car.

If body and truck bolsters are made stiff enough to prevent the deflection and permanent set necessary to bring the bearings into contact there will be no trouble, but this can be carried to an extreme which would not be permissable on account of the weight of the bolsters. It may be said here that the advantage of lightness would be with the roller side bearings and this is an incentive for the production of a good bearing of this type, for it would permit of using very light bolsters. The distribution of the load along three points in the length of the bolsters instead of concentrating it at the center has much to recommend it, and the problem is not to be finally settled without due consideration of the question of weight. It has been said that a car cannot be carried on six points, but it must be admitted that if side bearings may be used as supports the objection to a bolster with considerable flexibility are largely removed, and flexibility would assist in equal distribution of the load. It has been suggested by Mr. F. M. Whyte of the Chicago & Northwestern that bolsters may be lightened or, if not lightened, they may be made stiffer in service by a better arrangement of the car body truss rods, which will

bring the loading from the rods nearer the center of the bolsters. This seems to be an excellent idea and it will probably help materially in the right direction, which is to transmit the load so that it may be most favorably resisted.

Metal bolsters which will carry their loads by the center plates are now made by several firms, and the best solution of the problem at this time is to use them. It is very important to remember that a body and a truck bolster together form an important combination, of which each must do its part. It will pay to discard wooden bolsters as rapidly as possible and replace them by strong, stiff steel ones. Then let the man who has a good "anti-friction" side bearing bring it forward. It is also worth while to consider whether an "anti-friction" center plate bearing is not equally important.

THE METRIC SYSTEM.

This system has been before the world for a long time, and its adoption by nearly all civilized countries, together with the present tendency toward the extension of American trade, renders its consideration specially important at this time.

The United States and England have not yet adopted it, and the question is taking such shape as to affect the foreign trade of both countries. There are faults in the metric system, and this fact, coupled with the difficulties of changing methods of weighing and measuring, lead some influential persons to urge the perpetuation of the present systems, with an idea that the United States and England are important enough commercially to warrant the continuance. We do not believe this to be the right view to take. If we want foreign trade we must use the measures required by that trade, and it must be conceded that the use of the metric system must increase in spite of opposition. We shall go even further than this and say that in time the metric system will force its way through all our institutions in spite of efforts to stop it. Then shall we have two systems or one?

The time has passed, we think, for taking sides, and it will soon become necessary to either help or hinder progress. It is better to take a far-sighted view and fulfil our national promise for progressiveness. The period of change will be uncomfortable and inconvenient, but short, and we commend the expressions of Mr. Grafstrom and Professor Mendenhall, elsewhere in this issue, on this phase of the subject, for attention. All that is necessary is that the people shall see it to their advantage to use the metric system and the change will be made, and not until then. The situation warrants educational methods and they will undoubtedly be used with ultimate success.

Sentiment favoring the change in England is rapidly growing, and as an example of the expression of opinion there we quote the following from "The Mechanical Engineer," of Manchester:

"The British Consul in Amsterdam has reported that some time ago the iron and steel manufacturers throughout the German Empire adopted a standard classification based on the metric system. For instance, angle irons and bars, of which the production in Germany is very large, are rolled by all manufacturers to identical dimensions. This systematic procedure has led other foreign countries to adopt the German classification, more and more to the disadvantage of British manufacturers. The consul reports that in Holland there is an undoubted preference for German sizes, based on the metric system, and that it is chiefly owing to this that Germany has obtained many orders for railway bridges and other material. He adds that, 'as regards pipes for waterworks, it is absolutely certain that the Dutch market is completely lost to Great Britain as far as new works are concerned, from the same cause.' He says that recently a Belgian firm obtained a large contract for water-piping in Holland, and was obliged to guarantee that the German normal classification should be adhered to. He concludes that in the growing competition of rival manufacturing countries the lead cannot be held by any country which has not adopted the metric weights and measures. This opinion is fully confirmed by consular reports from other places, and the wonder is that we don't adopt the obvious remedy. But without a strong lead from the Government, we shall doubtless continue to drift along until it is too late to get back what we have lost."

TESTS OF LOCOMOTIVE LAGGING.

Comparative tests of materials for locomotive boiler insulation, when made under conditions differing widely from those under which it is used, are open to criticism, and even to doubt, as to the adaptability of the data obtained for comparison under service conditions. Tests have been made in still air, and with comparatively small surfaces covered with the insulation, and until now all such comparisons have been made in this way. It is well known that air currents affect the radiation, and that the best of insulation will not overcome the bad effect of lagging construction whereby air can get under the jacket, and it is clearly advantageous to have road tests in order to take this influence into account. Until very lately such tests have not been considered as a possibility because of the difficulty of securing data, but a plan recently devised by Prof. Goss and the mechanical officers of the Chicago & Northwestern Railway promises to throw new light on this side of the subject

We are informed that tests have already been undertaken on that road of a number of boiler coverings, the plan being to couple two engines together, the first of which has no fire and no water in the boiler, but is supplied with steam at a pressure of 160 pounds from the engine in the rear. The second engine pushes the first over the road, and the amount of water condensed by the same boiler with the different laggings while going over the road is weighed in the tender tank. It is true that the conditions of wind velocity and direction may not be uniform, but by careful work the results may be expected to be more reliable than any that have been obtained. The plan is both ingenious and novel, and if the weather conditions are favorable an interesting comparison may be expected. Without doubt wooden lagging will give a very poor showing, and the coverings which insure the best joints for the exclusion of air currents and at the same time are good insulators will be at the head of the list.

NOTES.

A test for determining the hardness of cast iron was described recently in a paper by Mr. C. A. Bauer before the American Foundrymen's Association. A drill press is rigged with a wheel and weight in such manner as to insure uniform pressure. The revolutions of the drill and the depth drilled are noted, and comparisons are thus made by which the relative hardness of different samples of iron are determined.

A moveable sidewalk with two speeds is to be installed at the Paris Exposition. Instead of the plans followed in Chicago and Berlin there will be a smaller number of driving wheels. These will be in the stationary track, spaced 127 feet apart, and will be electrically driven, giving motion to a central rail on the under face of the platform. The bearing wheels will be 20 feet apart, and will be placed under this rail, and will also carry the platform. The central rail supports half the weight of the platform, while smaller wheels at the sides carry the rest of the weight to side tracks. This plan gives great flexibility to the platform, which is in short sections and permits of using very short curves. The high speed platform will run at the rate of six and a quarter miles per hour, and the slow speed platform runs at one-half that rate. The tracks will be about two and a half miles long, with stations nearly 700 feet apart. The power required will be about 475 horse-power and the capacity nearly 39,000 passengers per hour.

The cost of large caliber ammunition in the present war is very great. A 13-inch gun firing a projectile weighing 1,000 pounds consumes 550 pounds of brown prismatic powder, costing from 30 to 33 cents per pound. "Engineering News" recently printed the following interesting figures: At the lower price the powder for a single charge costs $165. The common 13-inch shell is said to cost $116.63, but the armor-piercing projectile costs $418. To these items must be added cartridge bags, primers, freight, etc., amounting to about $15, or $296.63 for the shell discharge, and $588 for the discharge of an armor-piercing projectile. As a 13-inch gun can be discharged about twenty-five times an hour, the work of one for an hour may cost the Government about $15,000. The 8-inch gun costs about $65 for each shot; the 5-inch rapid-fire costs $33; the 6-inch breech-loading shot costs about $40, $14 being for the powder; and each round of the Hotchkiss 6-pounder gun is estimated to cost $5.70, and a 1-pounder $1.12. Whitehead torpedoes cost $2,500 each, and a Howell torpedo $2,220.

Oil fuel was tried at sea for the first time in the British navy at Portsmouth, on Friday, July 29. Some months ago the Admiralty sanctioned an experiment with the system invented by Mr. Holden of the Great Eastern Railway, on board the torpedo boat destroyer "Surly," and in the interval various trials have been carried out in one of the dockyard basins. At these the chief difficulty was to furnish a sufficient feed of oil, but this has been overcome by the provision of an overhead feed-tank. There are four boilers on the "Surly," two of which are still retained for coal fuel, but the others have been adapted for oil. In lighting the latter series the elements of combustion are oil and coal, but as soon as a sufficient heat has been generated bricks replace the coal and are heated from the oil spray. At the trial no difficulty was experienced in obtaining a sufficient spray, and the heat was so well maintained that at times the thermometer indicated 150 degrees F. in the stokehole. There runs over the measured mile in Stokes Bay were made, and, while a speed of 16 knots was hoped for, the runs gave a mean of 14 knots; but, as this was only a preliminary trial, the result was regarded as satisfactory. The oil used had a flash-point of 280 degrees F.

The remarkable trip of the U. S. battleship "Oregon" from San Francisco to Key West is full of interest, not the least of which is the part performed by the engineers, to whom the greatest credit is due for the fine condition of the machinery en route and after arrival. In a letter to a friend, published in the New York "Sun," Mr. C. N. Offley, First Assistant Engineer in charge of the "Oregon's" starboard engine room, tells the reasons for the successful trip in the great and constant care given the machinery, and concludes with the following tables of fuel and speed data taken on the cruise:

	Distance, knots.	Time, hours.	Speed, knots per hour.	Coal, tons.	Knots run per ton of coal.
Brewerton to San Francisco....	827.7	72	11.49	221.0	3.74
San Francisco to Callao........	4,076.5	371	10.99	962.0	4.24
Callao to Port Tamar............	2,529.9	212	11.93	785.0	3.22
Port Tamar to Sandy Point....	132.0	9	14.55	66.0	2.00
Sandy Point to Rio de Janeiro.	2,247.7	223	10.08	657.0	3.42
Rio to Bahia......................	700.0	*	*	288.0	....
Bahia to Barbadoes............	2,229.0	193	11.55	620.0	3.59
Barbadoes to Jupiter............	1,683.9	142	11.86	478.6	3.3
Jupiter to Key West............	280.0	27	10.37	77.9	3.6
Totals	14,706.7			4,155.4	

*Speeds variable. Data unreliable.

The effect of the long-distance telephone in overcoming the necessity for very fast limited train service between New York and Chicago is interesting. The "Railroad Gazette" directs attention to this development, and while unable to give definite statements as to the extent of the loss, it is believed to be considerable. The telegraph is not adapted to long conversations, and is relatively slow when compared with the telephone, but it is used to begin business conversations which are completed over the long-distance telephone lines, whereas people had formerly to actually meet in order to transact business that required haste, and this necessitated the use of fast trains. The result is advantageous to business men and is not all loss to the railroads, because long-distance "flyers" do not pay unless the excess rates are very high, and the roads may now confine their efforts to the difficulties of operation, which are bad enough, even with normal speeds. We are informed that the North Shore Limited 24-hour trains of the New York Central and the Michigan Central railroads leaving New York at 10 o'clock a. m. and Chicago at 4 p. m., have been discontinued. How far the telephone has assisted in this result is not known, but it is credited with a good share of influence.

The question of safety devices for the elevators of the new "Empire Building," just completed in New York, has been settled by the application of air cushions to ten passenger elevators. Each shaft is walled up independently as high as the third floor, and is made a close fit for the car, and the last fifty feet of the drop of each elevator is therefore in the air cushion. The elevator cars may fall into their cushions, whereupon the air is confined in the bottom of the shaft, and, by its gradual escape, lets the elevator down easily without shock. It is stated that a car has been dropped from the twentieth floor of this building without breaking eggs and incandescent electric lamps that were placed on the floor of the car. The pressure of the air caused by a fall from the top floor, a height of 290 feet, is calculated to be about three and a half pounds. The estimated proportion between the length of the cushion and the length of the drop is as one is to six. The advantages of this safety device are: Simplicity, reliability, absence of moving parts and the sacrifice of no room that could be used for any other purpose. The only precaution necessary seems to be to make the doors of the lower floor entrances air tight, and this is easy. This is an interesting case of the survival of an old idea that is good, and in the interests of safe elevator transportation in high buildings we would like to see more of these applied.

STEAM CONSUMPTION—STATIONARY ENGINES.

A four days' test on a Sulzer steam pumping engine by Bryan Donkin is reported in a recent issue of "The Engineer" (London), showing remarkably low consumption of steam.

The indicated horse-power at full speed was from 201 to 207, and 101 at half speed. The boilers were of the Cornish type, supplying dry but not superheated steam at 150 lbs. pressure. The heat efficiency was from 81 to 82 per cent., and the consumption was from 11½ to 12 lbs. per horse power when running at full speed, and it rose to 12¾ lbs. at half speed. The cylinders are 14 3-16, 23⅝ and 34 7-10 in. in diameter, with a common stroke of 39⅜ in. The cylinders and cylinder heads are steam jacketed. In commenting upon these figures "Power" compiled the following records of tests, showing less than 12 lbs. of steam per horse power per hour:

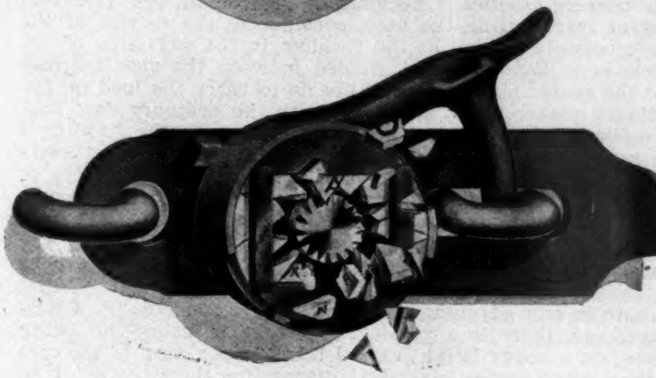
	Lbs.
60 H. P. Schmidt compound engine at Annen, Germany—reported by Hill—steam superheated 315° F..................................	9.55
100 H. P. Schmidt compound factory engine at Osnabruck, Germany—reported by Hill—steam superheated 267° F..............	10.41
700 H. P. Sulzer triple expansion mill engine at Chemnitz, Germany—tested by Saxon Boiler Inspection Co., and reported by Hill—steam superheated 18° F..	10.71
575 H. P. Leavitt triple expansion pumping engine at Chestnut Hill, Mass.—reported by Miller..	11.22
2,000 H. P. Sulzer triple expansion mill engine at St. Petersburg, Russia—reported by Hill..	11.30
575 H. P. Allis triple expansion pumping engine at Milwaukee, Wis.—reported by Carpenter..	11.68
1,300 H. P. Sulzer triple expansion mill engine at Orechowo, Russia—reported by Hill..	11.7
550 H. P. Greene-Wheelock cross compound mill engine at Grosvenor Dale, Mass.—reported by Barrus..............................	11.89
1,100 H. P. Allis triple expansion pumping engine at Chicago—reported by J. N. Warrington and R. W. Hunt Co..............	11.97

THE TRAVELING ENGINEERS' ASSOCIATION.

The sixth annual convention of the Traveling Engineers' Association will be held at Buffalo, New York, commencing Tuesday, Sept. 13, at the Genessee House. The list of subjects is as interesting as usual and a successful and profitable meeting is promised.

WOOD'S CAR SEAL.

The device known as Wood's car seal, which was formerly manufactured by the Q. & C. Co., and now controlled as well as manufactured by them, has met with such success as to warrant an illustrated description. The seal is in the form of a hasp and a hook combined. The hasp is of wrought steel, having a turret-shaped piece of malleable iron riveted to its center. The hook of the hasp is enlarged at its pivot end and surrounds the turret in the form of a strap. When the hook is raised to its uppermost position the seal, which is composed of a peculiar material as strong as glass, which will break in small pieces, is inserted into slots, where it is held behind the vertical bars. It is inserted from the right hand side, and when the hook is raised the portion of the strap surrounding the turret which is cut away at the bottom in the upper figure is brought opposite the slot to admit the seal. When the hook is then lowered in securing the door the movement of the strap locks the seal in position, and in this condition the door is safe from thieves, because the next upward movement of the hook breaks the seal, as shown in the lower figure.



Wood's Car Seal.

The rim of the hook operates a cam by means of a ratchet and spring in the inside of the turret in such a way as to throw the central plug, shown in the lower figure, out against the inner face of the seal, breaking it, whereupon it drops out of place.

The requirements for a good car seal as reported by a special committee of the Freight Claim Agents' Association in Chicago in 1893 are substantially as follows:

It must be so made as to prevent rusting from exposure to rain and snow and must not be clogged by dust. It must be self-contained, not requiring any instrument for application or removal, and its operation must be such as to prevent imperfect sealing by carelessness. The numbers or marks must be distinctly seen, because the records are often taken at night and in bad weather. The seals must be easy of application, beceuse they are applied in cold weather, when the hands of the sealer are likely to be incased in mittens, and finally, the cost of the seal and device for its attachment must be low.

The claims made for the device are that it cannot be tampered with without breaking it; it cannot be left half sealed without leaving the door unlocked, and in general it meets the conditions outlined as to what a good seal ought to be.

We are informed that some of the largest railroad systems in the country contemplate adopting this seal as a standard.

TRAIN SIGNALING IN ENGLAND.

Communication in trains whereby passengers may either stop a train or make known the necessity for doing so is now occupying the attention of the English Board of Trade, of the railroad men and of the traveling public of that country. The reason for agitating the subject so extensively now appears to be found in a desire to put an end to the atrocities made possible by the compartment system of cars used in England. To us the best solution seems to be a revision of the construction of cars upon the intercommunication plan. This, however, entails expense, and, whether finally accomplished or not, something needs to be done at once to remedy the existing evils. A committee of the Board of Trade has made a report, of which the following gives the substance:

"That of the methods of communication at present adopted the outside cord system should be condemned as inefficient, while the systems in which the cord or wire is inside the carriages cannot be regarded as satisfactory. The principal electric systems, and the communication by means of the brake may, however, be held to be efficient; that no one of the electrical systems so far excels the others as to enable the committee to recommend it for general adoption, although they prefer the system of communication which has been experimentally used by the Great Eastern Railway Company; that the law should be extended so as to require the provision on all trains of an efficient means of communication between passengers and the servants in charge of the trains, which should also be used as a means of communication between the guards and the driver."

The conditions which the apparatus should fulfill are stated as follows:

"It should lend itself readily to the interchange of carriages between different railways; it should be easily applicable, and should communicate directly with the driver as well as with the guards, while the means by which it is actuated by the passenger should be in a conspicuous position, either in the center or at both ends of the compartment, without affording too great a temptation to passengers to tamper with it; it should be reasonably cheap in initial cost and maintenance; it should afford an indication outside the carriage, and a passenger should not be able to replace the means by which the alarm is given; it should not entail the use of additional couplings to those already existing, viz., the screw coupling, the side chains, the automatic brake, and the heating apparatus; and it should be capable of being used as a means of communication between the driver and the guards of a train as well as between the passenger and the driver and guards."

The Board of Trade has expressed a preference for an electrical apparatus, devised by Mr. F. Hollins, Telegraph Engineer of the Great Eastern Railway, which to us seems decidedly complicated and unnecessarily elaborate. Its essentials are an electric circuit throughout the train, of which the Westinghouse air brake pipes form one conductor, a dry battery, a bell and a visual indicator on the engine, a bell and push button in the brake van, a lever switch in each compartment to operate the bells, and arranged to be locked when once operated and released only by the guard, an indicator on the outside of the car at each compartment to show in which compartment the lever switch has been operated, and a specially designed Westinghouse coupling which contains the electrical contact mechanism for attaching the wire circuits between the cars.

This is an exceedingly round-about arrangement which will undoubtedly meet the peculiar and exacting requirements of the Board of Trade, but why it should be made necessary to employ so complicated a system is beyond our comprehension. The Westinghouse air signal seems to be all that is desired in this country and it may be adapted to perform all the necessary functions of similar requirements abroad. The outside cord system has been so inefficient as to lead to the establishment of radical regulations, whereas a device of this kind should have a gradual growth or development, simplicity being always borne in mind.

The moral to be drawn from the experience of the railroads of England in this case is that they should take the initiative in providing safety appliances and not wait for outside pressure, due to aroused public opinion, to compel them to put on apparatus which is more elaborate than necessary or desirable. The air signal so generally used on our roads would probably now be thought to answer every purpose in England if it had been employed voluntarily when the need for better appliances was first felt. We have no Board of Trade at present, but unless our railroads bear in mind this principle of taking the initiative in regard to safety appliances and act upon it to a greater extent than in the past, similar restraints may be expected to be applied by the public in this country as in England.

A SMOOTH-RUNNING AIR COMPRESSOR.

A very extensive application of compressed air has been made by the Ingersoll-Sergeant Drill Co. at the works of the Tide Water Oil Co., at Bayonne, N. J., in which a saving of 178 boiler horse-power, which is equivalent to $4,450 per year, has been effected by the substitution of compressed air for steam in a number of the processes in refining. This is of interest chiefly to our readers in connection with the Class D air compressor, shown in the photograph, which was taken while the machine was running at a speed of 150 revolutions per minute. The machine is of the duplex belt driven type, and the

Ingersoll-Sergeant Duplex Belt-Driven Air Compressor.

appearance of the belt and of the engine and fly wheel indicate very smooth running. This machine has a stroke of 14 inches and is of the same type as those used by the Pullman Palace Car Co., at the Pullman Works, by the Lowell Machine Shop, Lowell, Mass., and others. The machine is well built, and is giving very satisfactory service. There are many cases where belt compressors are more desirable than direct-connected machines, especially when the main shop engine has a large amount of surplus power, and our engraving shows a good example of this practice.

CAR BEARINGS—CENTER PLATE VS. SIDE BEARINGS.

At the May meeting of the Western Railway Club the subject of the bolster bearings for cars was taken up in topical discussion as follows:

"With the Very Heavy Capacity of Cars Now Being Built, Is It Not Advisable to Transmit the Weight from the Body Bolster to the Truck Bolster, Equally Distributed Between Center Plate and Side Bearings, Instead of Carrying All on the Center Plate?"

Mr. A. M. Waitt, General Master Car Builder of the Lake Shore & Michigan Southern Railway, opened the discussion and said:

Some weeks ago our chief engineer wanted me to take a trip to a certain point on our road and see why cars loaded with 50,000 or 60,000 pounds of coal, and started, would not continue down a grade of 45 feet to the mile and on straight track, too. I spent a forenoon in running loaded cars around curves and on this grade, and starting them down with a bar. Some of them went all the way down, and others only part way. The approach to the sloping track was a curve, and we found that all the older cars, especially those that had trussed wooden bolsters instead of metal bolsters, for some reason or other the trucks would not straighten out after they had passed the curve; the flanges of the wheel pressed hard against the rail. You can at once see that under such circumstances, even after the cars were started with a bar, or were given quite a push with the locomotive, the friction between the car and the rail would be very great. There happened to be a rainstorm at this time, and the rail was somewhat slippery, which gave the cars all the advantage possible; yet we found car after car on which the trucks would not straighten out on the straight track. Later there were tried cars having metal bolsters, and the side bearings of which were in contact as well as the center plate, and yet those cars curved easily enough and went down on the straight track very readily.

The same condition must exist when we are hauling cars, loaded or empty, over the road, especially so when they are loaded. I think it is reasonable to suppose that we are expending a great amount of power trying to haul cars which, after they have gone around a curve, will not allow the trucks to adjust themselves properly to run on a tangent line.

Then came the question as to how a condition of that kind could be overcome. The first thing that would suggest itself would be to get the car up off the side bearings, and I examined car after car in going through the yard to see what condition they were in, and I think it safe to say that 999 cars out of every 1,000 are transmitting the load from the body bolster to the truck bolster through both center plates and side bearing. On many of the cars the proportion of the load transmitted through the side bearings is very large; I think it would be safe to say probably as great as is transmitted through the center plates, that depending a great deal on the original distance between the side bearings when the car is new, and also on the stiffness of the bolsters.

If it is attempted to carry the load entirely on the center plate, with large capacity cars, we are necessarily putting a very great strain upon the truck bolsters. It seems a reasonable conclusion, provided a side bearing can be so devised as to make the friction between the body and the truck side bearing practically nothing, or very small, that the ideal way of transmitting the load, considering the service of the truck bolsters as well as the freedom in the swiveling of the truck, is to have the load divided between the side bearings and the center plates. It will not do to carry the load on the ordinary center plate, and then have the ordinary cast iron or malleable iron or steel bearings in contact; the friction is too great, and after awhile, after the side bearings get rusty and the cars get somewhat out of shape and sagged more or less, the friction will be too great, as was the case with the cars I have examined.

Mr. Miller, Michigan Central Railroad—I think I may say that I stand almost alone in advocating swing bolster trucks for freight cars. I have always believed, and do believe, that if there is any advantage in using a swing bolster on a passenger car, there is a greater advantage in using the swing holster on a heavy freight car. I think 90 per cent. of the cars of the United States have rigid centers for their trucks; I do not favor the rigid center truck. I have given this matter of side bearings a great deal of thought. There have been roller side bearings—a single roller with a trunnion; my observation has been that such bearings wear flat on top, and then they are worse than the ordinary side bearings. I have experimented with roller side bearings, and we are now experimenting with one which we think is correct in principle, and I believe that something of that kind will have to be adopted. Roller bearings must be made in such a way that the rollers must roll. In designing our latest one, which we have now under most of our passenger cars, and which can be seen under our coaches at the Twelfth street depot, we used an intermediate bearing, the cone-shaped rollers working between the bottom and the upper plate, centering to the center plate. A lever compels this intermediate plate to move, and thus compels the roller to move, and the roller then does not wear flat. I have had such side bearings on a passenger coach for six years, and I think that the principle is correct.

President Delano—Two cases have come to my attention of serious loss on account of too much friction between cars and the side bearings of the trucks. The first is in line of great damage to track and rail. In the case of a bridge across the Mississippi River the bridge itself is on a tangent for more than half a mile, but the approaches on each side are on a curve. It has been found that the rail on what would be the continuation of the outside of the curve is worn twice as rapidly as the other rail. The only explanation is that the trucks become slewed by the curve and do not straighten out when they reach the tangent.

The second instance illustrates the resistance to traction. Cases of switch engines stalling with a very small number of cars going around curves have frequently come to my atten-

tion. One case was so absurd as to seem almost untrue, which I saw myself only a week ago. A four-wheel switch engine, which I have seen handle forty loaded cars on a straight line, stalled with a full head of steam, pulling eight foreign box cars loaded with grain, coming out of an ordinary switch lead in a yard. I found that the cars were all overloaded, but not more than 10 per cent. beyond their capacity; but the whole trouble was that they were bearing down hard on their side bearings, the gage of the wheels on the axles was at the extreme limit, and the wheels were grinding so on the track that it was just like pulling the cars up hill to pull them around the curve.

Although Mr. Waitt makes the point that the weight of the cars should be divided equally between the center and side bearings, it certainly seems that if that is done, and so large a proportion of the weight of the cars is to be carried on the side bearings, then at least we must have a better side bearing than is now usual.

Mr. A. E. Manchester, C., M. & St. P. Railway—The ideal place to carry a car on the truck is at the center, with the side bearings only performing the office that they are intended for—that is, to take the sway of the car; and we should strengthen our body bolsters and our truck bolsters. It is not impossible that a durable side bearing that will meet these conditions can be designed, but I doubt whether anything has yet been devised that will stand the test of durability and cheapness and do the work. I believe that it is possible to build body bolsters and truck bolsters of such capacity that such side bearings will not be necessary. I furthermore believe that the condition mentioned by Mr. Waitt does not exist to the same extent with swing bolster trucks as it does with the rigid trucks; also that the swing bolster is easier on the body of the car, and, as a result, the car will last longer, will be racked less, and will be in general better condition after years of service than were the rigid truck used.

Secretary Whyte, C. & N. W. Railway—I want to say a word in favor of supporting the car on center plates rather than on side bearings. A number of years ago a certain road took the trouble to oil the center plates of its freight cars. The road was known as rather a crooked road, to be sure, but an effort was made to keep the cars off the side bearings and to further assist the trucks to assume their normal position readily the center plates were oiled, the car inspectors being provided with oil cans having spouts long enough to reach the center plates.

Mr. Waitt—There is one difficulty in making bolsters stiffer for the increased loads that are being put upon the cars, and that is that we are limited in the height of the couplers, and we are limited as to the height of the floor frame of the cars above the trucks to suit platform and places where cars are unloaded. If we transmit the load through the center plate and the side bearings we are not compelled to have as stiff a body bolster, and many of the old ones that we have in service would be sufficiently strong if, instead of concentrating the load in the center, we divided it between three points. We get a more ideal way of loading by equally distributing the load.

President Delano—Do you know whether it is the practice among roads with turntables to make the bearings of the turntables at the ends, or is it the practice, as I presume it is, to have all turntables bear entirely on the center, and have the ends free.

Mr. Waitt—I think the tables bear entirely on the center, with the ends free, for one reason, if for no other, that there is plenty of opportunity to provide sufficient depth to get the required strength.

Secretary Whyte—I think one of the difficulties of Mr. Waitt's proposition is that it would be rather hard to distribute the weight over six points. The weight can be distributed on two bearing surfaces, or on three, if the three bear the proper relation to each other, but it is difficult, without suitable equalizing arrangements, to distribute the weight over more than three bearing surfaces and insure that each gets its proper proportion; the bolsters would not be sufficiently flexible to insure this, I think.

Professor Goss—It seems to me we are attempting to design cars so that they will not bear on the side bearings, and yet are, in fact, unable to secure the desired result. In effect, therefore, the theory is one thing and the practical results quite another. I believe the theory is right, and that practice should be wrought up to the requirements. To support a car on side bearings means unknown stresses at every point of support.

New London, Conn., is to have the most extensive naval coaling station in the country. The largest coal sheds, piers and facilities for coaling war vessels are to be erected there immediately under the authority granted by Congress at its last session, when the sum of $200,000 was appropriated for the work. The yard has been placed under the jurisdiction of the Bureau of Yards and Docks.

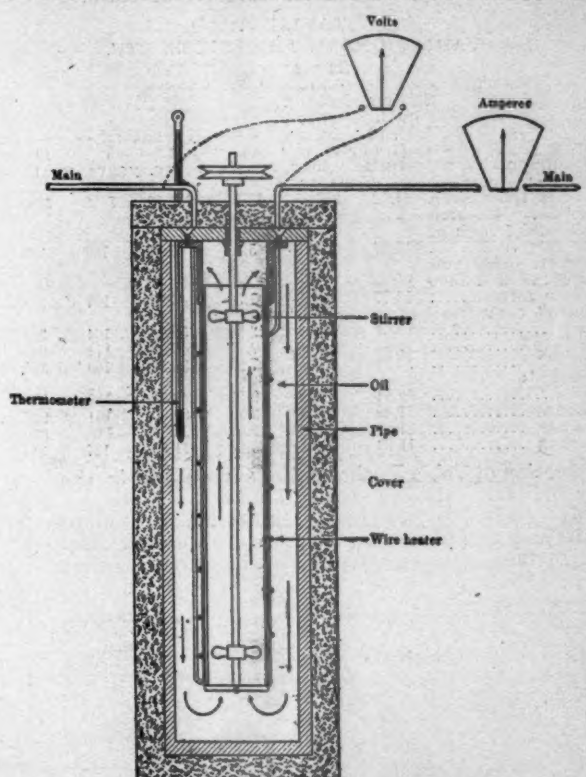
TESTS ON COVERINGS FOR STEAM PIPES.*

By C. L. Norton.

The apparatus for making these tests comprises several pieces of steam pipe of different diameters and lengths, heated electrically from within by means of coils of wire in oil. The oil is stirred vigorously and serves as a very efficient carrier of heat from the wires to the pipes.

In making a test the following operations are carried out, and observations are taken in the following order:

The current is turned on, and heat is generated in the wire coil until the wire, oil and steam pipe have reached the desired temperature at which it is proposed to test. The current is then gradually diminished until it is found to be of just the amount necessary to keep the pipe at this temperature without a rise or fall of 1-16 of a degree in 30 minutes. A reading of the voltage and currents is now taken at intervals of 30 seconds, and the watts and B. T. U. are computed from their average. We then have the number of B. T. U. lost from the outside of this particular pipe at this particular temperature. If now we place a steam pipe cover around the pipe, we shall find that a less amount of energy is sufficient to keep it at the required temperature, the difference being the amount of heat saved by the covering. It seems to me that I have approached



Apparatus Used by Prof. Norton.

more nearly the conditions of actual practice that can be obtained by any other method of testing, except the actual use of a long run of pipe; and the determination of the amount of heat put into such a pipe by the "condensation" method offers many difficulties and is open to much uncertainty. I feel, therefore, that in adopting this method I am using a reasonable exposure for the pipe, and have an exceptionally good opportunity to measure the heat supplied.

The money saving is computed on the following assumptions. Coal at $4 a ton evaporates ten pounds of water per pound of coal. The pipes are kept hot ten hours a day three hundred and ten days a year. If computations are made, as is sometimes done, on an assumption that the pipes are hot twenty-four hours a day three hundred and sixty-five days in a year, the saving is nearly three times that shown in the table.

Generally speaking, a cover saves heat enough to pay for itself in a little less than a year at 310 ten-hour days, and in about four months at 365 twenty-four-hour days.

Specimen.	Name.	B. T. U. loss per sq. ft. pipe surface per minute.	Ratio of loss to loss from bare pipe.	Thickness in inches.	Saving per year per 100 sq. ft.
A............	Nonpareil Cork Standard	2.20	15.9	1.00	$37.80
B............	Nonpareil Cork Octagonal.....	2.25	17.2	.89	37.20

*From a paper read before the American Society of Mechanical Engineers.

C	Manville High Pressure	2.38	17.2	1.25	37.20
D	Magnesia	2.45	17.7	1.12	36.90
E	Imperial Asbestos	2.49	18.0	1.12	36.80
F	W. B.	2.62	18.9	1.12	36.40
G	Asbestos Air Cell	2.77	20.0	1.12	36.00
H	Manville Infusorial Earth.	2.80	20.2	1.50	35.85
I	Manville Low Pressure	2.87	20.7	1.25	35.65
J	Manville Magnesia Asbestos	2.88	20.8	1.50	35.60
K	Magnabestos	2.91	21.0	1.12	35.50
L	Molded Sectional	3.00	21.7	1.12	35.20
M	Marsden Infusorial Earth.	3.11	22.5	1.00	34.85
N	Marsden Infusorial Earth.	3.27	23.7	1.00	34.60
O	Asbestos Fire Board	3.33	24.1	1.12	34.20
P	Calcite	3.61	26.1	1.12	33.24
	Bare Pipe	13.84	100	....	.....

By the advice of the members I have made an assumption that the cost is not nearly proportional to the thickness. As the thicker coverings are not now made in great quantities, the actual cost of their manufacture is uncertain.

TABLE V.

VARIATIONS IN THICKNESS, ETC.

Specimen.	Saving in B. T. U. per sq. ft. per minute.	Saving in dollars. per 100 sq. ft. per year.	Net saving. 1 year.	2 years.	5 years.	10 years.	Approximate cost.
Magnesia:							
1⅝-inch thick	11.62	$37.75	$7.75	$45.50	$159	$347	$30
Magnesia, 1⅝-inch thick and 1 inch of hair felt	12.38	40.22	5.22	45.44	166	367	35
Magnesia, 1⅝-inch thick and 2 inches of hair felt	12.77	41.50	1.50	43.00	167	375	40
Nonpareil cork							
1 inch	11.64	37.80	12.80	50.60	164	353	25
2 inches	12.84	41.75	7.75	48.50	174	383	35
3 inches	12.94	42.05	7.96	34.10	160	370	50
Fire board:							
1 inch	10.54	34.20	9.20	43.40	146	317	25
2 inches	11.48	37.25	2.25	39.60	151	337	35
3 inches	11.70	38.00	12.00	26.00	140	330	50
4 inches	11.83	38.40	26.60	11.80	127	319	65

Inspection of Table V. shows the saving due to the use of hair felt outside a standard Magnesia cover.

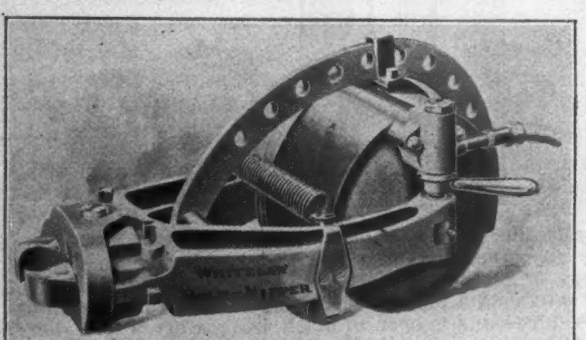
In five years 100 square feet of hair felt saves $7 more than its cost, and in ten years it saves $20 above its cost.

The further saving due to a second inch outside the first is $8 in ten years. Of course, the well-known tendency of hair felt to deteriorate should be considered.

In the case of Nonpareil Cork, increasing the thickness from one to two inches raises the cost from about $25 to $35 per 100 square feet, and increases the net saving in five years by $10 and by $30 in ten years. In other words, the second inch of material in use about pays for itself in two years, while the first pays for itself in about one year. The third inch does not increase the saving even in ten years. The second inch, therefore, more than pays for interest and depreciation, while the third fails to do this.

In the case of the Asbestos Fire Board, a second inch in thickness causes a saving of $20 in ten years, the third and fourth inches showing a loss.

In general it may be said, therefore, that if five years is the length of life of a cover, one inch is the most economical thickness, while a cover which has a life of ten years may to advantage be made two inches thick.



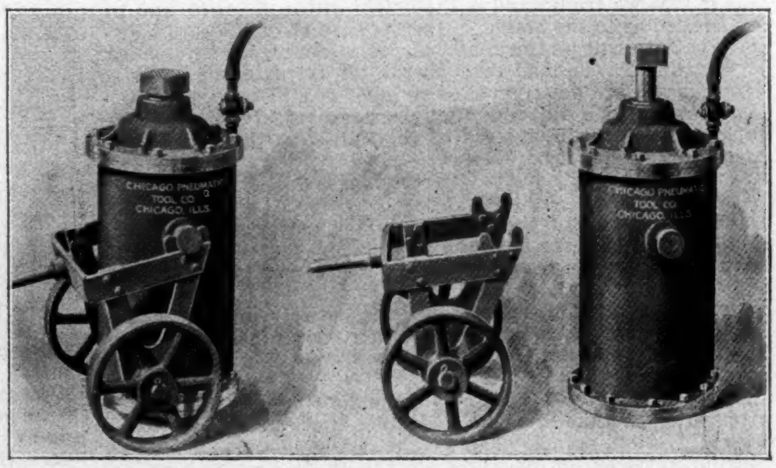
Whitelaw Staybolt Nipper.

CONVENIENT PNEUMATIC APPLIANCES—CHICAGO PNEUMATIC TOOL COMPANY.

In our July issue we gave an outline description of the new tools introduced by the Chicago Pneumatic Tool Company, and now present engravings of three devices which have proved themselves to be especially valuable in machine and boiler shop equipment.

Car and Locomotive Jacks.—The design of these jacks is very simple, not differing in essentials from others that have been in use in railroad shops for some time. They are compact and are well made and well finished from good material. The cylinders and heads are of cast iron, with bolted machine joints, and the pistons are of cast iron, with leather packing. The piston rods are of steel, surmounted by bearing blocks that are free to turn on the piston rods. The air pipe connection is made through the upper head, and the pressure is controlled by a cock. The capacity now ranges from 5 to 25 tons, several of the latter having already been ordered. Trunnions are cast on the cylinders and the jacks may be carried about on a neat two-wheel metal truck, which will fit the trunnions of all of the jacks. The design is arranged with a view of producing jacks that may be easily used and conveniently transported, and which will not require repairs.

Bolt and Staybolt Nipper.—This appliance is so clearly shown in the engraving as to be readily understood. It has a short cylinder between the long arms of two levers, the short arms of which are fitted to receive the hardened cutters. The long arms are returned to their closed position by strong coiled springs, attached to the outside of the levers, where they may be seen and cared for. The nipper is suspended by a bail with a number of holes by which it may be held in any desired position. The machine is adapted to work in restricted quarters. These machines are well made and may be easily taken apart for overhauling. They work rapidly and are controlled by a lever operating a

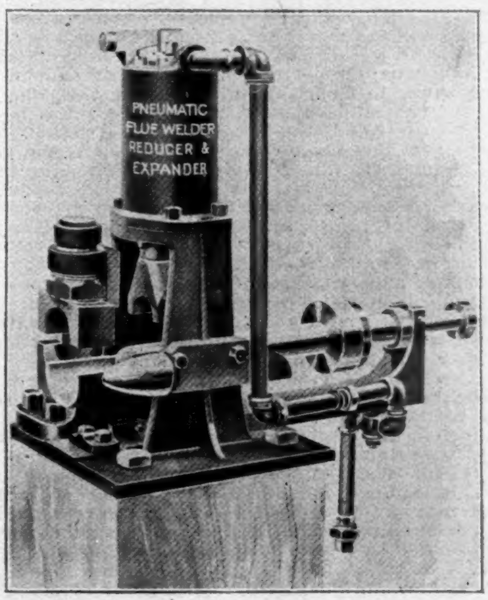


Car and Locomotive Jacks.

valve at one end of the cylinder, shown in the engraving. Two sizes are made. No. 1 will cut bolts up to 1 inch in diameter, and No. 2 will cut bolts as large as 1½ inches. Their capacity is limited only by the ability of the operator to move them to the work.

Pneumatic Flue Welder, Reducer and Expander.—This machine is a combination of devices perfected and improved from the original devices known as the McIntosh flue welder and the Whomes flue reducer. They are combined on one bed plate that may be bolted to the top of a small post in the shop, the only power connection being a single piece of rubber hose. Shafting being avoided, the machine may be set up anywhere, and the air pipe carried to it. The machines are very ingenious; they are well and strongly built, and are automatic in the sense that the introduction

of a flue to its proper position for working opens the air valve, and the operator has only to place the flue in position and turn it until the work is done; when withdrawn the air valve closes and the machine stops. The work is done by reciprocating hammers driven by pistons controlled by ingenious tappet valves, which admit and release the air from the cylinders very rapidly. It is a compact combination, and if desired the welder and reducer may be mounted separately, and the reducer may be used in connection with other forms of welding machines if desired, although we should think the two ought to be used together. The machine is usually placed near the heating furnace, and the capacity is limited only by the dexterity and skill of the operator. As many as 300 flues have been reduced in an hour, and as this work may be done after the welding and at the same heat the convenience of the machine will be clearly understood. It is stated that this reducer when used with the Hartz welding machine will save from 3 to 5 hours on a single set of flues. The dies may be changed in a few minutes. Reheating and



Pneumatic Flue Welder, Reducer and Expander.

handling are saved, which means very rapid and cheap work. They will weld and reduce a flue in about 8 seconds when operating under a pressure of 40 pounds per square inch. The pressure is reduced by reducing valves before the air passes into the machines.

There is nothing more awkward than the arrangements for flue work as we have seen them in many railroad shops, and this compact outfit, with its labor-saving possibilities, cannot fail to make a mark on flue work. In writing us recently about the operation of this machine, Mr. McIntosh, Master Mechanic, C. & N. W. Ry., said:

"It was originally designed for welding alone. Later Mr. Whomes attached an auxiliary hammer and dies for reducing, and, finding it a success, designed an independent reducer that can be used in connection with other machines, the Hartz, for instance, reducing the flue at the same heat that welds it. We find these machines reliable and durable and remarkably rapid. It takes but five seconds to weld and reduce a flue. Consequently, the heating furnace regulates the output. We use the Furguson oil furnace, a very excellent heater, but the flue welder and reducer would easily keep three of them busy. Both machines are automatic, starting in motion only when the flue is placed under the dies and stopping instantly on its withdrawal, using air but a few seconds at each operation and economizing power to the greatest degree. Other advantages are cheapness and small floor space required."

THE MICROSTRUCTURE OF BEARING METALS.*

BY GUILLIAM H. CLAMER,
Chemist to the Ajax Metal Company, Philadelphia.

The science of microscopic metallography is at present attracting widespread attention, and great developments have of late resulted from this mode of testing. Microscopic examination is fast becoming a factor in testing metals. In the study of iron and steel much work has been done and much information obtained; but the microscopic examination of alloys is a comparatively new piece of research. Chemical analysis can show only the composition of an alloy; but to show the true structure, or manner in which the component parts are alloyed, is left for the microscope. The physical properties of a sound piece of steel depend exclusively upon its chemical composition and upon its structure, and just so with all other alloys; not only should the component parts thereof be known, but also the manner in which these metals are alloyed, as is shown by their structure. We may take, for instance, bearing metals. In these alloys two all-important points requisite to a good bearing alloy, namely, anti-friction and wearing qualities, are greatly dependent upon structure.

It is, of course, first necessary to have the composition correct to meet certain requirements, such as load, speed, etc., and then to have the component parts alloyed in such a manner that the product shall be as fine-grained and homogeneous as possible. The failure of many bearings to give satisfactory service is more often the result of improper mixing than of a poor composition.

It is an undisputed fact that certain combinations of metals are better than others, but it frequently happens that an alloy of good composition is far inferior to another of poor composition, simply on account of improper manipulation; a good composition in the hands of unskilled foundrymen often yielding a granular and uneven mixture of very inferior quality, while a good metal can be made of inferior scrap by another.

How the wearing qualities are dependent upon structure will be made evident when we consider the definition of wear—"the tearing off of small particles from the worn bodies." Therefore, a bearing metal which is finer in granular structure will wear the slower because of the tearing off of smaller particles.

If a metal is not homogeneous, the anti-frictional qualities will suffer greatly, because of the difference in the hardness and density of the metal in all its parts. The particles of such an alloy form hard spots within the metal, which produce friction.

The homogeneity is greatly dependent upon the treatment the alloy has undergone, and a perfectly even structure can only be obtained by careful and proper treatment.

In view of these considerations, I was led to make a study of the structure as well as the composition of the various bearing metals on the market in this country, and more particularly those which are used in railroad service.

The question as to what is the best metal on which to run our rolling stock is one which is becoming more important every day. We are running our trains on faster schedule; we are increasing the size and weight of locomotives and cars to acquire greater speed, greater carrying capacity and greater comfort.

Only a comparatively few years ago railroad men would have laughed at the idea of attaining the train weights and speeds of to-day. They would have advanced a hundred difficulties in the way of achieving such wonderful results, and chief among these would have been cited the difficulty of obtaining a bearing metal which would meet these requirements. In former times, when speed was not attained and comfort but little considered, a "hot box" was of little consequence; but now the numerous trains are required to dash along with marvelous regularity, reaching their destination after a run of hundreds of miles on the very minute they are scheduled to arrive. Under these conditions even the slightest delay often leads to the most disastrous consequences. Many accidents are on record which can be traced to a hot box.

Apart from the safety and successful movement of trains, which can be accomplished only by the use of well-fitted, well-lubricated bearings, composed of a properly made anti-friction alloy, the question of cost is also an important factor—not only first cost, but also the expense which is directly dependent upon the wearing qualities of the alloy and its successful use as scrap. A metal to be successfully used as scrap must have the quality of not deteriorating in remelting. The importance of these considerations is at once obvious to a well-regulated railroad, which considers the great loss occasioned by wear, and the necessity of converting their scrap again into a first-class journal brass.

The alloys now in use for this purpose may be divided into five classes:

(1) White metal alloys; (2) miscellaneous alloys; (3) copper and tin alloys; (4) phosphor-bronze; (5) copper, tin and lead alloys.

Cast iron has been tried as a journal metal on railroads, and in fact was used for some years, but I think that it has now been entirely abandoned for the composition metals. Roller bearings have also been experimented with, but, so far as I am aware, have failed to give satisfaction.

The preparation of these alloys for microscopic examination is, of course, of first importance. They must be carefully polished and then etched with a suitable reagent. For copper

*A paper read before the Franklin Institute.

alloys I prefer to use the method of Guillemin, i. e., to attack the specimen electrolytically by exposing it for a few minutes in a bath of very dilute sulphuric acid when connected with a simple Daniel cell, and, in making a comparative study of metals of similar composition, all the conditions must be the same. The method I use is to make a platinum dish, containing the weak acid solution, the positive pole, and then immerse the specimens to be compared in the solution in contact with the dish, and pass a current through them all at the same time.

The white metal alloys belong to the first class. They are first in anti-frictional qualities, but do not wear well, and, furthermore, have not sufficient strength to support the great weight of locomotives and cars without distortion or crushing. The practice, therefore, is to use these metals inside of a stronger shell of composition metal.

In car bearings these soft alloys are simply used as a lining, which is not more than 1-16 to ⅛ of an inch in thickness. The object of this lining is to give the bearings a good seat without having to be bored out accurately to fit the diameter of each individual axle. The diameters of the axles vary according to the wear they have had, and to fit hard-metal bearings it would be necessary to bore each one to fit each particular axle, and, moreover, the axles are always more or less rough. The soft white metals easily conform to any such irregularities in the surface of the axle.

This soft composition soon wears away, but by the time this has taken place the bearing has a good seat on the axle, thus doing away with the necessity of fitting each separate journal. The boxes are all bored out to the same diameters and lined with a specified thickness of soft metal. In this way the bearings are all fitted with minimum expense and confusion. The principal alloy used is one containing antimony and lead; this is sold on the market under the name of "hard lead." It usually contains from 15 to 25 per cent. of antimony, which makes the alloy coarsely crystalline and brittle. It is inexpensive, but gives little wear. Although antimony is a more expensive metal than lead, the "hard lead," or antimonial lead, sells at a lower price than pure lead. The microstructure shows these coarse crystals (Fig. 1). With the increase of antimony the crystals are brought into closer contact, indicating the approach to the chemical alloy. Tin greatly improves this alloy. It gives it greater toughness, and makes an alloy which will stand a much greater pressure without distortion—a valuable feature for a babbitt metal.

This is the composition of nearly all the cheap babbitt metals on the market. A good babbitt metal should have as fine a grain as possible in connection with the greatest toughness and hardness obtainable. Tin has the property of greatly reducing the granular texture of antimonial lead. Bismuth in small quantity is added to the lead, antimony and tin alloy by some manufacturers. It is claimed to give greater fluidity and less distortion under pressure. The composition of such an alloy is:

Lead	80.00
Tin	4.75
Antimony	15.00
Bismuth	.25

The question of obtaining a fine-grained structure depends greatly on the method of manufacture, temperature of pouring playing an important part, but generally the size of the crystals increases with the increase of antimony, as does hardness; but by proper manipulation a finely crystalline metal can be obtained in an alloy of the following composition, which has a high percentage of antimony, thus making it a valuable babbitt metal:

Lead	70.00
Antimony	20.00
Tin	10.00

The first white metal successfully used as a bearing metal was invented by Isaac Babbitt. It contained tin, antimony and copper. This metal is used for lining purposes, but can be cast into solid bearings which do not carry too great a load. All white metals used for bearing purposes are now sold under the name of babbitt metal, and when used as a lining the bearing is said to be "babbitted." But to distinguish this metal from the cheaper lead alloys it is sold under the name of "Genuine Babbitt." This alloy is harder than the lead alloys, much tougher, and is finely crystalline and wears well. It is much more expensive, owing to the content of tin. The composition is as follows:

Tin	80.00
Copper	10.00
Antimony	10.00

Another alloy very successfully used is one composed of:

Tin	68.00
Zinc	31.50
Copper	1.00
Lead	.50

It is very tough and bends many times without breaking, due to the peculiar interlocking of the crystals (Fig. 2). It has, however, the bad feature of pouring sluggishly. I have no knowledge of the wearing qualities of this metal.

I will next consider the miscellaneous alloys. Under this head may be included any alloy, it matters not what the composition, so long as it produces a reasonably good casting. It includes all alloys having over 60 per cent. of copper and the remainder made up indiscriminately of zinc, tin, lead, antimony and any other metals which happen to be in the scrap pile.

Such compositions as these are used on freight cars, and, indeed, by some roads in passenger service, their only aim being to get a cheap composition. No attention is paid to wearing or other qualities, and the running expense is not taken into account; it is only first cost. If a bearing gets hot or wears out, it is removed and thrown into the scrap pile, to be again remelted. Foundrymen receiving this scrap term it all "red brass," and without any knowledge of the composition again convert it into journal bearings.

The scrap pile always contains more or less zinc, and indeed anything from yellow brass up is considered good enough for a cheap bearing metal.

Fig. 3 shows the structure of yellow brass of:

Copper	66 2-3 parts
Zinc	33 1-3 "

It is beautifully crystalline and the size of the crystals varies greatly with the method of treatment. Zinc has the property of giving greater solidity to alloys of copper, tin and lead, 1 to 2 per cent, being sufficient for this purpose, and when more than this is used in connection with other scrap the effect is more or less injurious. If the scrap metal coming from the railroads was first melted and run into pigs and analyzed, uniform results could be obtained by building up the scrap with new metal to the desired composition; but the present low price of such material would not warrant this extra expense; and, indeed, I have known of such bearings to be cast, bored out and lead-lined for 7½ cents per pound. But even so, with proper care, a fairly good metal can be made from such scrap.

Fig. 4 shows a bearing metal made of scrap which has been carefully treated; it contains a high percentage of lead, but shows no liquation of the lead, as would be expected in an alloy of this nature.

Fig. 5 shows a copper and tin alloy, containing a little lead, in which manganese has been used as a deoxidizer.

The alloy of copper and tin some years past was considered the standard bearing metal on railroads, but is now little used. These metals alloy to form a very hard and crystalline alloy (Fig. 6), the usual proportion being that of cannon bronze—7 parts of copper to 1 part of tin. Although this alloy is much harder than the standard metals of to-day, yet it is found to wear much more rapidly and produce more friction. Dr. Dudley, chemist to the Pennsylvania Railroad, some years ago gave the results of a long series of experiments before the Franklin Insititute, in which he compared the copper and tin alloy with the standard phosphor-bronze, which contains lead. He found that the copper and tin alloy was much more liable to heat under the same state of lubrication than the standard phosphor-bronze, and second, that the rate of wear with the copper and tin alloy was nearly 50 per cent. greater than that of the standard phosphor-bronze. And still, in spite of these facts, some railroads still go on in the old way specifying copper and tin, a more expensive alloy than the phosphor-bronze, or the copper, tin and lead composition.

These experiments led directly to the use of standard phosphor-bronze bearing metal on the Pennsylvania Railroad, and indirectly to its use of other large roads. Thus, by practical experimentation and experience, railroad men to-day recognize but two alloys as standard: (1) Copper, tin and lead alloy, containing phosphorus, known as phosphor-bronze. (2) Copper, tin and lead. I do not say that either of these alloys is the best that can be devised, but up to the present time, and with our present knowledge, they are the best compositions for car and locomotive journal bearings. As far as wearing is concerned, I do not think the phosphorus introduces any advantage, and, as Dr. Dudley says, he has no evidence to show that the phosphorus has any other use except to produce sound castings.

I had occasion very recently to find, by a practical test, that the alloy of copper, tin and lead gave better results, so far as anti-frictional qualities are concerned, than the alloy containing phosphorus. That the bearings without phosphorus showed a much less tendency to heat than the phosphor-bronze was clearly demonstrated. The test was made by placing the phosphor-bronze on one side of the axle and the simple alloy on the other. The tests were strictly comparative in every way, and the number of hot boxes of the phosphor-bronze metal greatly exceeded the simple alloy. And it has been found, by practical experience, that remelted phosphor-bronze is much more liable to heat than the newly-made metal.

In order to discover why the remelted scrap phosphor-bronze should be inferior to the newly-made material, I determined to make some experiments in a practical way. The fact that the phosphor-bronze scrap is far inferior to new metal is well known, and I believe the general impression has been that the inferiority was due to the burning out of the phosphorus, as it is for this reason that the specifications of standard phosphor-bronze call for a high percentage of phosphorus, in order to make provision for loss in remelting, and with the idea that the remelted scrap will still retain sufficient phosphorus not to deteriorate its qualities. By my experiments I find this to be an entirely mistaken idea, because, in the first place, phosphorus only burns off in very small proportions, when once thoroughly contained in the alloy; and secondly, that the inferiority of the metal is directly due to the high percentage of phosphorus, for the reason that it combines with the tin and copper to form hard crystalline phosphides, which are, to a great extent, dissolved in the alloy when the metal is new, but separate or crystallize out in the old material.

Six hundred pounds of phosphor-bronze was made of good selected material, and every precaution used in manipulating. It was then poured into ingots and borings taken from the first, middle and last ingots, and the borings mixed and analyzed. The analysis showed:

Copper	78.72
Lead	9.82
Tin	10.58
Phosphorus	1.04

Three hundred pounds of these ingots was now weighed off and remelted, and again poured into ingots and weighed, and the loss carefully noted; the metal being melted and poured in this way ten times, and the loss noted in each heat, with the following results:

	Pounds.		Pounds.
1st	3.5	6th	2
2d	3.0	7th	3
3d	3.0	8th	3
4th	2.5	9th	4
5th	3.5	10th	7

The total loss was 34.5 pounds, or 11.5 per cent., on ten heats, and the average loss per heat 1.5 per cent. It will also be seen how uniform was the loss on every heat; the last heat only showing considerable deviation, which I attribute to the metal being insufficiently hot to flow cleanly from the crucible.

Borings were taken from the first, middle and last ingots of the tenth heat, well mixed and analyzed. The metal now contained its constituents in the following proportions:

Copper	80.39
Tin	10.40
Lead	8.35
Phosphorus	.87

The analysis shows that very little phosphorus has gone off, despite the fact that the metal was melted and poured ten times, the lead showing the greatest loss. The following table will show the loss in weight very closely, as shown by the analysis:

	1st Heat.	10th Heat.	Loss in Pounds.
Copper	235.47	213.41	22.06
Tin	29.67	27.61	2.06
Lead	31.74	22.17	9.57
Phosphorus	3.12	2.31	.81

These results show that the phosphorus is held in bronze in the form of phosphides, which high temperature can drive out only in very small proportions. The metal under the microscope was now decidedly crystalline. These crystals are intermixed or held dissolved in the new metal, but when subjected to remelting become organized and crystallize out in the alloy, thus greatly reducing the anti-frictional and wearing qualities of the metal. The resulting metal after the tenth heat was so hard it could scarcely be touched with a file.

Fig. 7. New phosphor-bronze.

Fig. 8. Remelted phosphor-bronze.

A copper, tin and lead alloy of the same composition was treated in the same way; the loss on this metal was 34 pounds, being within half a pound of the phosphor-bronze, and the loss on each heat was as follows:

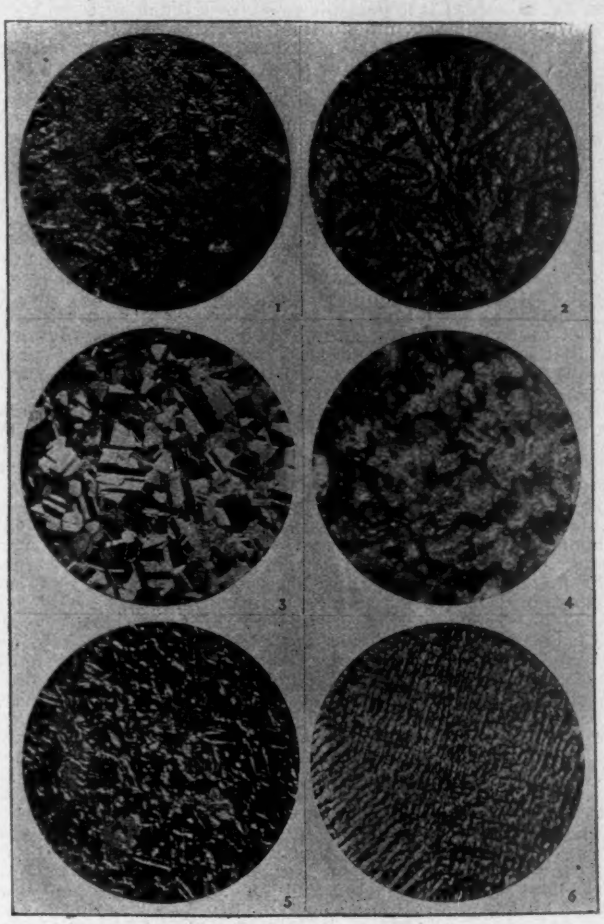
	Pounds.		Pounds.
1st	7	6th	4
2d	3	7th	2
3d	1.	8th	3
4th	4	9th	3
5th	4	10th	3

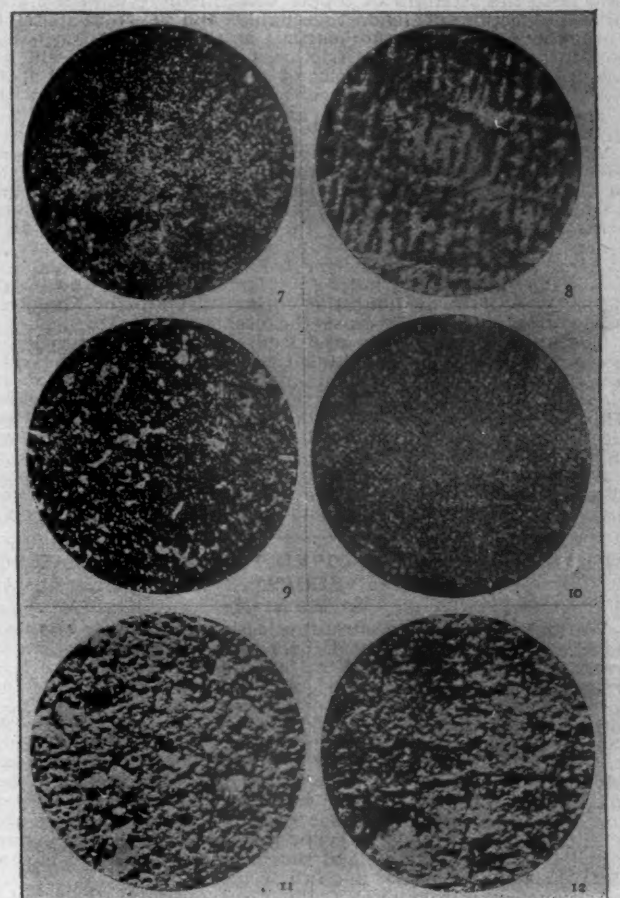
This metal became harder and closer-grained after the repeated meltings, but showed no signs of becoming crystalline or granular.

Fig. 9. New copper, tin and lead alloy.

Fig. 10. Remelted copper, tin and lead alloy, made by the Ajax Metal Company's process, which insures the homogeneous distribution of the lead.

Many alloys of copper, tin and lead are manufactured by foundrymen under the name of anti-frictional metal, and are sold under various well-sounding names, which are supposed to indicate their qualities.





Figs. 1.—Antimonial lead. 2.—Tin and zinc with little copper and lead. 3.—Copper and zinc. 4.—Copper, zinc, tin, lead, iron. 5.—Copper and zinc with little lead (manganese used as deoxidizer). 6.—Copper and tin. 7.—Copper, tin, lead and phosphorus (1st melting). 8.—Copper, tin, lead and phosphorus (after repeated meltings). 9.—Copper, tin and lead (1st melting). 10.—Copper, tin and lead (after repeated meltings). 11.—Copper, tin and lead, showing liquation of lead. 12.—Copper, tin and lead, showing liquation of lead.

Diagrams Made from Magnified Sections.

To one who is unacquainted with or does not consider the chemical and physical properties of lead, it appears an easy matter to make such an alloy by merely melting in a crucible the three metals in the stipulated proportions; but when we consider the greater density, the lower melting point, and the slight affinity of lead for the copper and tin alloy, a more serious question results. I have found, by my repeated microscopic examinations of many such alloys of different makers, that lead is in no instance combined or really alloyed with the copper and tin, or perhaps only in small proportions, probably not over 1 per cent.; the remaining lead being held diffused through the alloy in its combined state, or with small proportion of the tin and copper, but not enough to destroy the grayish-blue color.

Such an alloy under the microscope is seen to be made up of two principal colors, the bronze-colored combined copper and tin, and the grayish-blue lead. Now, this being the case, it will be seen how difficult and also important it is to obtain an alloy which will show the same structure and percentage of lead in all its parts. The difficulty in obtaining such an alloy is this, as I have stated:

(1) The lead is not combined with copper and tin.

(2) Owing to the high specific gravity and the lower melting point of the lead, its tendency is to go to that part of the casting which has last solidified, or to distribute itself unevenly throughout the mass.

I will now show the structure of copper, tin and lead alloys of several makers; they all have about the same composition and were all cast in the same size bars, great care being taken to have the conditions as nearly alike as possible. A section was cut out of the middle of each bar for examination.

Fig. 11 shows the structure of an alloy of the following composition:

Copper	76.88
Tin	10.62
Lead	11.71

It shows that the lead has liquated, leaving an unsound metal. The dark spots are holes and the lighter particles lead. That such a segregation of the lead greatly reduces the value of a composition of this nature is very evident.

Fig. 12. A metal of following composition:

Copper	76.66
Tin	11.68
Lead	10.83

This shows a still greater segregation of lead. In this metal the lead is very unevenly distributed, it having formed large pools through the alloy.

Of all metals, lead is by far the first in anti-friction qualities; and if to the strength of copper and tin there is added a suitable proportion of lead, thoroughly and evenly distributed throughout the mass, the bearings as they wear are constantly in contact with soft anti-friction particles of lead, which are backed by the harder particles of copper and tin. If in such an alloy the lead is not homogeneously distributed and without liquation, both the wearing and anti-frictional qualities are greatly affected.

After going through the whole subject of the composition of metals suitable for bearings, the thoroughly homogeneous alloy of the proper portions of copper, tin and lead seems to me to be best suited for the purpose, and this has also been demonstrated in actual service by the use of such alloy on all the record-breaking trains of recent years, notably the New York Central & Hudson River flyer from Albany to Buffalo, which made the run of 436½ miles in 407 minutes, with the bearings perfectly cool throughout the entire run; and on the fleetest ocean greyhounds that cross the ocean.

The alloy of copper, tin and lead, of proper composition and homogeneous structure, I think I am safe in saying, has greater anti-frictional qualities than any other composition of sufficient strength to be used as a journal brass in railroad service. This fact has been demonstrated several times by actual practical tests, and, furthermore, it does not deteriorate in remelting.

As structure is of such importance in a bearing metal, I think the micro-test should be included in all specifications as equal, if not greater in importance than chemical analysis.

ADVANTAGE OF IMPROVED TOOLS FOR RAILROAD SHOPS.*

We find that where a careful selection and proper application has been made of improved tools in shops the saving in time over the old methods of getting out the same class of work is so great as to set aside all doubt and beat down all prejudice heretofore existing in the minds of a few mechanical men who are loth to depart from old and tried ways. Your committee finds that the introduction of truly improved tools for meeting special railway repair shop work has been slow, considering the great advantages derived from their use, and from facts ascertained in making our inquiries, we are satisfied that a large majority of our master mechanics are not reading upon or keeping posted with the progress made by some of their brothers in this important line, or if they are, then their managements fail to appreciate their efforts, or act upon their suggestions.

As your committee on the subject of motors, in their full and complete report at our last convention covered this field so well, we decided not to touch to any extent upon this part of what is considered by many as pertaining to our subject of improved tools; at the same time we want to emphasize and indorse all the committee suggests and to add that even since their report was submitted rapid strides have been made in the invention and introduction of powerful and convenient motors having electricity and compressed air to actuate them and with the advantages of being adapted to special or universal service which enables them to cover almost every variety of work for which detached or independent motion is desirable, and the extended use of them in connection with the latest improved tools designed to work with them is strongly urged by your committee. The great improvement made in heavy shop tools and the very successful efforts to introduce features in them for wider scope and greater capacity is familiar to all who have looked into the subject, and your committee assumes in the matter of heavy lathes, planes, slotters, shapers, etc., that all interested are posted, and we propose to confine our report to the more special tools, those gotten up with a view of dispensing with all work formerly done by hand where possible to machine it.

These are the great labor and time savers, and consequently do as much, and in some cases more, to reduce cost of repairs on locomotives than the heavy tools, and, strange to say, they have received but little attention in proportion to their worth, if we may judge from the lack of general introduction. These consist in part of milling machines, vertical, horizontal and universal, turret lathes of special design, special brass lathes, grinding machines, tool sharpening devices, cold sawing and cutting off machines, threading machines for turned bolts, etc., to dispense with cutting threads on lathes, and some of the latest designs of light shapers, slotters and quick return planers.

Possibly the most important of the improved tools are the latest designs of milling machines. With these we are enabled to machine almost any part of locomotive machinery that cannot be handled in our lathes and planers, and also finish and fit parts that could only be done by hand heretofore, and owing to their ease of adjustment we are enabled to design work to be machined by milling very cheaply that would have been difficult, if not impossible to handle in any other machine. A visit to some of the large building shops where heavy milling machinery has been so generally introduced would be quite a revelation to those who have failed to keep up with the subject. There seems to be no limit to their usefulness, and but few, if any, jobs arise in ordinary practice that cannot be handled in a well designed milling machine. Your committee finds that the introduction of light milling machines years ago, which could be used only for cutting gears, fluting reamers, taps, etc., and which proved too small to be of any general use, had the tendency to prejudice many shop men against them, and the fact that only recently such machines as are calculated to take the place of planers, slotters and other tools have been available, has no doubt had much to do with the slowness of shop managers to take hold of them, but now that it is possible to select a machine to suit your work we strongly recommend their use, and find that a saving of at least 20 per cent. over the ordinary planer can be obtained where a heavy milling machine is worked up to its full capacity on most work.

Perhaps the next most important, if not equal, adjunct in the way of improved tools for machine shop is the turret lathe. These tools are now made very strong and heavy, designed to cover a large variety of work, and for nearly all kinds of turning from the solid bar.

With a properly built turret lathe not only are bolts for engine work, but all pins, bushings, collars, etc., for any description of machinery, etc., can be rapidly produced, and accurately duplicated. The attachment for threading makes them much faster and more accurate than the old method of threading in ordinary lathes. Your committee recommend none but the best and heaviest turret lathes. There are many on the market like the poor milling machines, and not worth the room they occupy. Too much care cannot be exercised in selecting what are considered improved tools for shops, and this applies with great force to tools for railroad shops, where we cannot afford many, if any, costly special tools, but must confine ourselves to purchasing such improved, or even ordinary machines, that are as universal as possible in their action. We find that with the best designs of turret lathes in the hands of smart and intelligent operatives who adapt the machines to the work in hand, and work them to full capacity, that a saving of from 45 per cent. to 55 per cent. can be obtained in all kinds of bolt and pin work, over the ordinary methods of doing this work in lathes.

Your committee finds that great improvement has been made in the machinery for handling brass work in shops, and, notwithstanding we are constantly trying to reduce, or dispense with connections and attachments as far as possible, we still have a large number of brass and other metal fittings to produce, and shops that are prepared, or desire to make their own oil cups, gauge cocks and standard brass fittings, would do well to look into the matter. Many of the best of these machines will lessen the cost of production of this class of work at least 50 per cent., and the output is far superior in fit and finish, owing to the arrangements for accurate duplication. There are now available several makes of quick return high speed planers and shapers for light work designed to keep all small jobs out of the heavier tools, and where a shop is confined to two or three planers, all of them probably 36 inches or over, with one or more heavy shapers, one of these machines will be found not only very convenient, but most profitable. They handle rod keys, liners, keys for frames, etc., and for quick time on brass work of all kinds, are indispensable. These newer designs are small, but heavy and compact, and should not be confounded with the flimsy little machines so generally on the market, with which all shop men have become disgusted, owing to poor design, extreme lightness and uncertainty of feed, etc.

Your committee is pleased to note the more general tendency on the part of many shop men to take advantage of the suggestions made and points given on this subject in our former reports of committees on this subject. It encourages us to hope our efforts are appreciated, and that good is being done by the Association's action in keeping this most important matter to the front. This is especially apparent in the number of pneumatic and electric motors in use, and particularly the former. We find but few shops who new depend upon the old ratchet for drilling and reaming, and the number of belt and rope conveyors, and old-fashioned devices for obtaining motion, are growing less every day. We find that where compressed air is being used in connection with the best motors for drilling, reaming, boring, tapping, chipping, calking, screwing in stay bolts, riveting tanks, ash pans, and many other uses, that the average saving over the old hand methods is from 35 to 40 per cent., and on some jobs, is over 50 per cent., particularly in drilling shops where ratchets were formerly used. The average saving in boiler shops fully equipped with good pneumatic tools to cover all lines where they have proven an advantage is about 50 per cent., and by some who have given the matter much thought is considered much above this figure when great saving in time engines are laid up for boiler work is counted. We find fewer improvements in our blacksmith shops than in other departments of railroad works, the old methods prevailing in them to a much larger extent than in others, and we suggest to our master mechanics, and foreman blacksmiths, to go around, or write for particulars as to what is being done in this line at some of our leading railroad shops, those of the Union Pacific at Omaha, the Santa Fe at Topeka, and many others, having introduced compressed air with great results on certain work.

Outside the shop proper, in the yards and buildings for storing material, scrap iron, is a great field for saving labor by conveniently arranged pneumatic lifts and motors, many foremen

*Report before the Master Mechanics' Association, June, 1898.

being able to do with two or three men what kept ten or a dozen busy, such as loading and unloading wheels, tires, boiler plate, heavy castings and lumber. In addition to the saving in time, the liability to accidents to employees is greatly lessened by the safer and surer manner of handling and the fewer men employed. Your committee could not procure figures showing the relative economy of these yard appliances, but their ultimate saving must be apparent to all.

We find a great improvement in many of the wood working machinery departments of our railroads; this is particularly true of those shops who build a part of their new equipment; the improvement in planing and matching machines, borers, mortisers, sawing machines, and, in fact, all wood working machinery has been so rapid in the past few years as to be a question "if it would not pay many roads to dispense with the whole of their antiquated old plant and replace it with just half as many well selected tools designed for their work, that would turn out more work in a day than they now get out in a week?"

Before concluding our work on this subject, we desire to call the attention of our Association to a few things that have struck us most forcibly while inquiring into the matter. First, the great difference existing in the methods of prosecuting work even on our improved tools in the average railroad shop, as compared with a well organized and hustling manufacturing establishment in about the same line of business. The factory producing for the market to make a profit seems actuated throughout by a different impulse from the average railroad shop, even where piece work has been long established, and none of the railroad shops seem able to get quite as much advantage of their special improved tools as is accomplished in the factories—in other words, they are not worked up to their capacities as continually. We have, of course, made due allowance for the difference actuating the employees, and the difficulties to be met by foremen and others in our railroad shops, and we simply mention this in connection with the economy of improved tools.

Second—In some shops we found milling machines that were idle which could have been well adapted to many kinds of work being done in planers, shapers and slotters; these would have been greatly relieved and much other work done in them that the mill could not handle by proper management and suitable cutters being provided for the mills. No pains should be spared to provide every device for utilizing the milling machine to its fullest capacity and keep it going all the time. When once realized its great usefulness cannot be overlooked, and its place is never filled by any other machine.

Among other improved tools that seem to contribute largely to the increased output of such shops as have taken advantage of them are the cold sawing machines; these are used for cutting off machines, and also for cutting to given lengths all kinds of shapes, rounds, squares, flats and ovals of almost any section, evening up channels, tees, angle irons, etc., and also cutting them to given lengths with great ease and rapidity as compared to old methods. These machines are also indispensable in the building of iron and steel tender frames, trucks, etc., and for the boiler maker they supply a long-felt need, while they contribute to every department around a works; none but the heaviest and best should be introduced; the great scope of their work entitles them to the closest consideration in selecting shop plants, and we invite special attention to them. A reasonable estimate of their saving over old methods is about 35 per cent. to 50 per cent., according to character of work to be done, and with them all cross sections, such as are met in tender frame construction, are made perfectly.

We have not touched upon shop cranes as yet. We almost hesitate to do so, as so few ordinary repair shops are able to provide them; at the same time we all admit the desirability of their extended use. A large majority of the older shops are so arranged as to prevent the use of overhead traveling cranes, but the introduction of electric motors has made it possible where the change can be afforded for some of our railway shops to erect them. Where this cannot be done the work can be greatly facilitated by putting up at needed points the best forms of chain hoists in connection with pneumatic lifts, etc., as in the case of other improvements mentioned. A visit to some of the shops where this has been done will assist greatly in givin an idea of what can be done to do away with the old plans of "main strength and awkwardness" so prevalent in many shops that have lots of work to do; they are the greatest time and labor savers that we have, and their importance cannot be over-estimated.

It has been suggested to your committee that a more proper subject for consideration in this line would have been "the advantages of modern tools and modern methods in railroad shops," for the reason that there is opportunity for a larger proportionate saving in the ordinary well equipped plant by changes in methods than by the adoption of the latest tool which may be on the market.

THE DIESEL HEAT MOTOR AT THE MUNICH EXPOSITION.

Consul General Frank H. Mason, writing from Frankfort, Germany, to the State Department under date of June 25, describes the status of the Diesel motor in Germany. This motor was illustrated and described on page 265 of our August issue.

In a previous report by Mr. Mason, describing briefly the new caloric motor invented by M. Rudolf Diesel, it was stated that at the machinery exposition to be held at Munich this summer a collective exhibit would be made by the several firms and companies in Germany which have begun the manufacture of Diesel motors of different types for practical use.

The exposition was opened early in the present month and will continue until October. The display of Diesel motors occupies a special building, and, in view of the originality and vast economic importance of the new engine, is recognized as the most interesting feature of the exhibition. The interest manifested in this invention by American engineers and machinists has been so general and insistent that a brief account of what can be seen at Munich during the coming three months may be of timely import, although it is generally known that all patented rights for the construction and use of the Diesel motor in the United States have been acquired by an American companay whose main office is at No. 11 Broadway, New York.

The collective exhibit at Munich is made by the Augsburg Machine Company, where the invention of Mr. Diesel was first built and tested in practical form, Messrs. Fred Krupp, in Essen, the Machinery Construction Company of Nuremberg, and the well-known Otto Gas Motor Manufacturing Company of Deutz-Cologne—four of the most important and powerful manufacturing firms in Germany, whose names form a sufficient guaranty of the industrial value of the new engine. The Diesel motors on exhibition are five in number, and are described in the official catalogue as follows:

1. By the Augsburg Machinery Company: Single cylinder, 30 horse-power motor, for petroleum fuel; drives a rotary pump that lifts 389 gallons of water per minute to a height of 196.7 feet.

2. By Fred Krupp of Essen: Single-cylinder, 33 horse-power engine, which drives a high-pressure, centrifugal pump that draws up from the River Iser a stream of water that is projected through a 2-inch nozzle at 45 degrees elevation to a distance of 230 feet into the river.

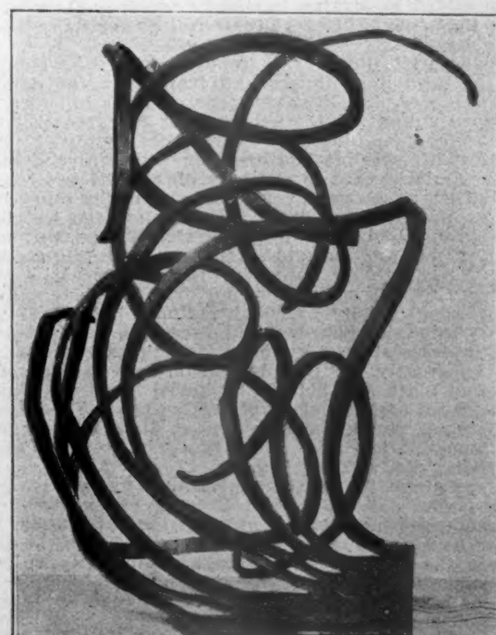
3. By the Machinery Construction Company of Nuremburg: A single-cylinder, 20 horse-power motor, which, at a speed of 180 revolutions per minute, is used for purposes of test and demonstration.

4. By the same company as above: One double-cylindered, 40 horse-power motor, coupled directly to a Schuckert dynamo, and at 180 revolutions per minute generates current for lighting the pavilion and driving a fast rotary printing press and several machine tools which are installed in the same building.

5. By the Otto Gas Motor Manufacturing Company of Deutz-Cologne: One single-cylinder motor of 20 horse-power, which propels a Linde condensing machine for the production of liquefied air.

HEAVY CHIPPING WITH A PNEUMATIC HAMMER.

The accompanying engraving shows an enlarged view of the piece of boiler plate which formed part of the exhibit of the Chicago Pneumatic Tool Company at the Saratoga convention mentioned on page 238 of our July issue. This steel boiler plate is ⅝-in. thick and not 7-16-in., as previously stated. The



Example of Work Done by a Pneumatic Hammer.

work was done with a No. 1 Boyer pneumatic hammer, and the chips are over 5 ft. long. The cutting was done at a rate of about 15 ins. per minute and without vibration or injury to the hand of the operator.

ASSOCIATION OF SUPERINTENDENTS OF BRIDGES AND BUILDINGS.

The Association of Railway Superintendents of Bridges and Buildings, through its President, Mr. Walter G. Berg, directs our attention to a circular relating to the eligibility of railroad men for membership in the Association. The requirements are expressed in a resolution passed at the convention held in Denver last year, and it is desired that the benefits of membership should be taken advantage of by as many as possible among the men who are eligible. The resolution was as follows:

"Resolved, That, in the opinion of the Executive Committee, the following clause of the constitution referring to the eligibility of an applicant for membership, namely: 'Any person at the head of a bridge and building department on any railroad, or a division or sub-division, and to include assistant superintendent and general foreman of any railroad, shall be eligible to membership.' should, in accordance with the action of the Association in the past, be construed on the basis that the applicant must be in the employ of a railroad company, either as a superior officer with general control over questions affecting the bridge and building department, or as a subordinate official having actual responsible charge of work connected with the construction or maintenance of railroad bridges or buildings, independent of the actual title, whether as superintendent, supervisor, engineer, general foreman, general inspector, master of road, master carpenter, etc., but not to include persons only in sub-charge of individual jobs or special classes of work, such as gang-foremen, inspectors, clerks, draftsmen, etc."

The Association will hold its eighth annual convention at Richmond, Va., Oct. 18 to 20, 1898, the programme for which includes a number of interesting subjects of reports of investigation.

CYLINDER FASTENINGS FOR LOCOMOTIVES.

On page 250 of our July issue an abstract of the report of a committee of the Master Mechanics' Association on "Best Form of Fastenings for Locomotive Cylinders," was printed. The Chairman of the committee, Mr. J. E. Sague, was unable to assist in the preparation of the report, and submitted additional discussion as follows:

The strains on cylinder fastenings, as well as upon other parts of locomotives, have been much increased within the last few years in the notable rise in boiler pressures, which has resulted in a more marked increase in locomotive power than is indicated by comparison of cylinder sizes only. Thus many recent designs of locomotives have 20 by 26 cylinders with 200 pounds boiler pressure, or the equivalent of a 23 by 26 cylinder with 150 pounds of steam. Modern systems of tonnage rating have also added to strains imposed upon locomotives, making it certain that they will exert their full power more constantly than ever before.

A decided limit, however, is imposed upon the weight of material to be used in cylinders and frames by the demand for high boiler power, and it is very common for builders to have specifications submitted to them calling for greater boiler capacity than can be obtained within the permitted limits of weight, after all possible has been done to lighten other parts. It will be admitted that in order to obtain the best road locomotives, either passenger or freight, the boiler must be made as large as possible, and with this in view the weight of all other parts must be kept as low as design will permit, assuming reasonably good handling and attention to running repairs, and this condition should be kept carefully in mind in considering the design of cylinders, frames and cylinder fastenings.

The principal strains to which cylinder fastenings are subjected are thoroughly discussed in the committee's report. The effects of these strains on cylinder fastenings, however, are believed to be greatly modified by the use or absence of a foot plate. A foot plate well bolted and keyed holds the frames rigidly in line with each other lengthwise and thus reduces greatly the racking strains upon the cylinders due to the action of the steam. Consolidation and other types of locomotives which have no foot plate, thefore, require exceptional strength in the cylinder fastenings, unless the equivalent of a foot plate is provided.

In recommending designs of cylinder fastenings distinction should be made between passenger and freight locomotives, even where the cylinder power is the same. Passenger locomotives exert their full tractive power only at starting and the cylinder fastenings are not exposed to as severe continuous strains as those of freight engines. Passenger locomotives, as a rule, also receive better care. Large boiler power is of such supreme importance in passenger locomotives that the weight of all other parts must be reduced as much possible. These considerations, it is believed, justify the use of lighter cylinder fastenings than would be good practice for freight. This is especially true for eight wheel passenger locomotives, whose truck and driving wheel weights are apt to be close to the track limit.

Referring to the connection of cylinders to boiler, the replies indicate but little trouble with this fastening. Several recommend double bolting either front or back or on the side flanges. Double bolting front and back or on the side is extensively used on heavy locomotives and in a few cases cylinders are double bolted all around. Double bolting front and back has the advantage of lengthening the cylinder fit on the smoke arch, and enables the maximum number of bolts to be placed through the smoke box rings, but for equal weight of metal in the flanges the double side bolting enables more bolts to be used.

Regarding the connection of cylinders to frames and the design of the frames at the cylinders, practice varies greatly and it is difficult to lay down any rules which will be of general value; especially is this true regarding the choice between single and double bar front frames. Double front frames give a more secure cylinder fastening than can be obtained with single rail frames. They make an especially good design for consolidation, mogul and other locomotives in which the drivers are close to the cylinders, and are being widely adopted for heavy ten and twelve wheel locomotives. Considering the strength of the frames only, the design of double front frames involves the use of more weight for equal strength than with single, and this is an important reason for the continued use of single front frames on so many recent eight-wheel passenger locomotives. For this type of locomotive the great length of single front rail permits some flexibility, and there is less liability of the strains being concentrated at breaking point than if the rails were short. With the single front rail bolted on a line with the centers of the cylinders the strains due to the steam pressure are taken directly. With double front frames these strains are exerted mostly upon the bottom rail, as this rail is necessarily much nearer to the center of the cylinder than the upper one. The bottom rail, therefore, requires nealy as much section as if a single rail only were used. The breakages of upper rails, however, show that important strains are transmitted through them, and these are probably quite complex. Very great strains are brought on the upper rail by the expansion of the boiler, especially when the expansion pads are binding. Any yielding or springing of the bottom rail will also throw disproportionate strains on the upper one. The experience of members indicates that to avoid trouble with double front rails it is necessary to design them so as to be as free from bending strains as possible and to connect them so that they will resist the strains almost as if made of one piece; otherwise the rails may yield and break in sections. The indications point to bending strains localized where the working and breakage are noticed and it is also believed that this working was largely caused by the sticking of the expansion pads on the sides and back of firebox. To resist these strains more successfully filling blocks are put in and are found to meet the difficulties successfully. For ten and twelve wheel locomotives which involve greater length between the forward pedestal and the cylinders the filling pieces are thought to be even more necessary than in mogul and consolidation locomotives, and it is believed that double front frames not provided with such bracing will give more trouble than single bar frames. Mr. Middleton of the Baltimore & Ohio advises single front frames on eight-wheel locomotives and on ten wheelers having a considerable distance between the front pedestal and the cylinders. Mr. Vauclain writes: "We recommend single front rails for frames on engines having a four-wheel truck ahead, and double frames for two-wheel trucks. In any case where the single front frame is radically out of line with the draw head double frames should be used."

The writer believes that the following is good practice: Double rail front frames should be used on all consolidation and mogul locomotives, and on heavy ten and twelve-wheel freight locomotives, especially where built for mountain service. Single front frames should be used on eight-wheel passenger locomotives, as they have been found amply strong for this class of engine with good design of maintenance, and because the use of double frames would necessitate increased driver and truck weights for a given boiler capacity. The same applies to fast passenger ten wheelers where great boiler power is desired and where close limits of weight are to be conformed to. For large ten-wheel passenger locomotives to be used on mountain work or in exceptionally severe service, the better cylinder fastening obtained by the double front frame makes its use advisable. Filling blocks should be used for double rail frames, as before indicated, and the splices between the front and main frames should, as far as possible, be designed to avoid bending strains. . . .

To prevent cylinder saddles breaking, due to the expansion of boiler, some members recommend outside vertical ribs. These, with the lower cross ribs shown and with the bolts through the outside lugs which the ribs form at the frame connections, are believed to make a very secure job.

Regarding the advisability of using cross ties front and back of cylinders or long transverse bolts through the cylinder saddles, there has been a strong expression of opinion from members in favor of using one or the other of these devices. For double front rails, cross ties lipped over the top rail and shrunk on front and back of the cylinders assist in tying the frames to the cylinders and also greatly help the connections between the cylinder saddles. The action of the steam in the cylinders tends to spring the frames otherwise and separate the cylinders where bolted together, thus practically bringing a cross bending strain upon the saddles, and the cross ties are very effective in resisting these strains. Cast iron, although very strong in compression, is deficient in tensile and transverse strength, and it

is therefore believed that wrought iron cross ties serve a better purpose in reinforcing the cylinder saddles than would be obtained by increasing the saddle length, and with much less increase of weight. Where cross ties are used suitable flanges, of course, should be provided on the cylinders to resist the pull of the cross ties. Inside lips on the cross ties are unecessary, and if well fitted prevent the cross ties being shrunk on after the frames are bolted in place. The advantage of cross ties is shown from the fact that they are used successfully to hold cylinder saddles after cracking, and therefore cannot fail to assist in preventing cracking. Long transverse bolts through the cylinder saddles serve the same purpose in holding the saddle together as cross ties, and have been found very useful on many roads, but they are not thought to be as effective as cross ties, as they do not assist in holding the frames to cylinders and cannot be spaced as advantageously to resist bending strains in the saddles. They are useful, however, for cylinders having single front frame connections. Where used they should be placed as low down in the saddle and as near the back and front as possible.

BOOKS AND PAMPHLETS.

"Railway Construction," By William Hemingway Mills, M. Inst. C. E., Past President of the Institution of Civil Engineers of Ireland and Engineer in Chief of the Great Northern Railway of Ireland, New York, London and Bombay: Longmans, Green & Co., 91 Fifth avenue, New York, 1898. Large octavo, 366 pages; many illustrations and index. Price $5.

This is an excellent book on English railway construction, giving in considerable detail the methods of conducting work in construction and maintenance of stations, bridges, foundations, track, culverts, walls, sidings, switches, interlocking, signal and brake apparatus and some general treatment of locomotives. The work opens with the location and government regulations, followed by chapters on works of construction and permanent way, stations and other buildings. Sidings, turntables, water tanks and water columns are treated in turn, after which a whole chapter is given to weights and types of locomotives. Signals, interlocking, telegraph and staff systems occupy another chapter, and the closing pages treat of railways of different ranks, progressive improvements, growing tendency for increased speeds with corresponding increase in weight of permanent way and rolling stock, the last subject treated being electricity as a motive power.

What may be termed the massive solidity and conservatism of the book is best expressed by quoting its closing paragraph: "Strength and efficiency are the leading points which must be always kept in view, and the engineer must never forget that he is solely responsible for the safety of the line and works, and that of the public passing over the same." Instead of presenting details of construction Mr. Mills attends chiefly to general principles and leaves the application of these to those who educate and train engineers for their work. He shows many examples from practice, and these have evidently been selected with great care in order to record only what is trustworthy. He also leaves matters of cost to others, but it is clear that he does not always consider the matter of cost as sufficiently important. We believe that American practice shows examples of equally good methods that are sometimes much less costly. He does not like our flanged rails, preferring the "bull-head" section, saying of the flange rail: "Having fewer parts, it makes a cheaper road than the bull-head rail, but is not considered so strong or suitable for heavy and fast traffic."

When he writes of brakes for freight service he is amusing; for instance, he says on page 46: "Every goods wagon should be fitted with a brake, and it would be of immense value if that brake could in all cases be applied and controlled when the train is in motion." This is followed by a detailed description of an American freight car hand brake, and herein is a commentary upon English freight brakes, because of our ordinary hand brakes being considered interesting enough to take the space of a book that is intended to be up to date. A primitive braking appliance, the "sprag," is described. It is a wooden bar passed between the wheel spokes to skid the wheels and assist in safely passing heavy downgrades. We would suggest that English railroad men order a car load or so of Westinghouse catalogues. The work under consideration is certainly weak in regard to brakes, but throughout we see indications of a desire to benefit from foreign practice when it appears to be available. For example, American "bogie" engine trucks are illustrated and the author says: "Its recommendations are its simplicity, its efficiency and its accessibility for inspection and lubrication." Mr. Mills appears to be afraid of heavy locomotives, thinking that they are not steady and safe on the rails. He means to be always on the safe side of every question. He approves the ten-wheel type as used in the United States.

The strongest feature of the book is in presenting a large number of examples of successful practice. It will have the greatest value in countries where English practice is followed, and it records much that American engineers ought to know about. As presenting a general view of railway construction, from the point of view mentioned it is successful.

The engravings are good, the letterpress excellent. It is printed on unusually good paper and the binding is serviceable. It has an index, but we would like to see more cross references.

"The Indicator Handbook." Part I. The Construction and Application of the Indicator. By C. N. Pickworth, Editor the "Mechanical World." 126 pp., 81 illustrations. D. Van Nostrand Company, 23 Murray street, New York. Price, $1.50.

This is a valuable little book. It treats of the indicator, its use and its errors, while Part II. will treat of indicator diagrams and their analysis. There is much that is new in Part I., the illustrated descriptions of the Wayne and the Simplex instruments having their springs outside of the instrument, and away from the influence of the steam, being specially noteworthy. These indicators are described here for the first time in a work of this kind. The Wayne indicator uses a rotary instead of reciprocating motion for the piston and the card is held on a curved shield, the pencil movement being radial to the paper. The descriptions of these and the more common instruments are well written, and the author takes pains to bring out the characteristic features of each type and each design. All the reliable instruments are included. Indicator attachments and reducing motions are given a good share of space and the errors of the indicator itself and of the reducing motions are very fully treated. The most common rigs are shown in small scale drawings, and below them are scales which show the errors very clearly. Among the errors of attachment are those due to long pipes and long cord connections. Methods of testing are described. The book will be useful to engineers, even those who have had a great deal of experience with indicators, and to students it will be valuable as a text book. It is up to date and its purpose is so well carried out that we look forward to the appearance of Part II. with considerable interest. Part I. is complete in itself, it is well written, printed and illustrated, and is of a convenient size, 5 by 7¼ in. The author shows that he thoroughly understands his subject.

"Universal Directory of Railway Officials, 1898." Compiled from official sources by S. Richardson Blundstone, editor of "The Railway Engineer"; price 10 shillings. The Directory Publishing Co., Lim., 8 Catherine St., Strand, W. C., London. Representative for the United States: E. A. Simmons, 717 Chauncey St., Brooklyn, N. Y., 1898; pp. 475; boards.

We look upon this publication as a necessity in any office where there is occasion to look up the names and addresses and amount of equipment of foreign railroads. The revision this year has been carefully made, as usual, and brought up to date as nearly as possible in a work of this character. The new lines added are in Denmark, China, Nicaragua and Soudan, and also light railways in the European countries. The preface states that, with exception of the African German colonies, information respecting every railway in Africa is now included in the directory. Twenty-five pages have been added to the directory section and the personal index has been made proportionately larger.

"Administration Report on the Railways in India" for 1897-1898, by A. Brereton, Esq., Director of Railway Traffic and Statistics, Part I., Simla, 1898, Government Printing Office.

"Some Statistics of Engineering Education," by Dr. M. E. Wadsworth, President of the Michigan College of Mines, Houghton, Michigan. A reprint of a paper read before the Lake Superior meeting of the American Institute of Mining Engineers.

"The Elective System in Engineering Colleges," by M. E. Wadsworth, Ph. D., Director of the Michigan Mining School, Houghton, Michigan. A paper reprinted from the proceedings of the Society for the Promotion of Engineering Education, Buffalo meeting, 1896.

The Russell Snow Plows and Flangers, 1898.—The Russell Snow Plow Co., Mr. J. W. Russell, Manager, Tremont Building, Boston, Mass., has issued a new catalogue illustrating and describing their plows. The pamphlet gives 28 pages of information concerning the construction of the plows for different classes of work, and also giving the weight, dimensions and other information necessary for intelligent ordering of this equipment. The Russell snow plow has been developed by long experience which has led to successful use at speeds as high as 35 miles per hour into side hill drifts and diagonal banks of snow, which in some places attained a depth of 14 ft. in curved cuts, and even 50 miles per hour under other conditions. A longitudinal section of one of the large plows shows its construction to be such that the frame transmits the force from the engine to the front of the plow, so as to keep it upon the track, and those who are investigating the subject of snow plows should examine the construction of this type. The trucks under the front ends are exceedingly heavy and strong. They are of the diamond frame type, with four frames and eight journal bearings for each truck, the axles having bearings both inside and outside of the wheels. The plows are of different sizes and forms and are adapted for fast trains on single track, for right or left hand running on double track and for combined shoveling and flanging. The wing elevator plow is designed to leave a clear road over 16 feet in width, which is accomplished by the use of wings pivoted to each side of the car and one of these may be omitted from the plow if desired. The elevators on the wings are inclined planes which cut under the snow, and lift and throw it from 30 to 60 feet away, according to the speed of the train. On railroads with two or more parallel tracks these wings lift and throw the snow clear of the right of way and clean it out from between the tracks. A specialty is made of flanges, which are so constructed as to be strong and durable and at the same time easily operated by hand or compressed air. The pamphlet contains a record of snow plows from this company during the winter of 1896 and 1897 on the Northern Pacific Railway in North and South Dakota, that winter being an exceedingly severe one as regards snow blockade. A plow was used in hard, frozen snow from 9 to 12 ft. in depth over both rails, and in temperatures as low as 18 degrees below zero. The statement says: "On March 5 was the most severe storm, a blizzard, continuing for over 24 hours. The plow was run from 25 to 45 miles per hour, with 2, 3 and one 4 mogul engines with 18 by 24 inch cylinders behind it. The miles run were as follows: On main line 1,042, on branch line 531, a total of 1,573 miles. In spite of the fact that unusually hard work was done, part of which was upon branch lines with a poor road bed, the plow never left the rails, nor was it broken or disabled; neither was there any accident to the snow plow or its train. An equally satisfactory record is shown for work on the New York Central & Hudson River Railroad.

"Pop" Safety Valves.—The Consolidated Safety Valve Company, 111 Liberty street, New York, have just issued a new catalogue containing illustrated descriptions of the various styles of "Consolidated Pop Safety Valves," manufactured by them, including several new styles not previously illustrated. The importance of using only the best safety valves is first pointed out and several styles of nickel-seated valves are illustrated, after which three pages are filled with testimonial letters from such concerns as the Babcock & Wilcox Company, the Stirling Company, the Abendroth & Root Manufacturing Company, the Heine Safety Boiler Company and the National Water Tube Boiler Company, all of whom are using these valves on their water tube boilers. In a letter from the concern first mentioned it is stated that: "Out of 3,737 safety valves of your make which we have put out there has not yet been a single unsatisfactory valve." Over 200,000 pop safety valves have been sold by this firm, and the catalogue states that none of them, to their knowledge, have ever failed to work with satisfaction. Five pages are devoted to valves for marine work, and letters are printed from Wm. Cramp & Sons, the Newport News Shipbuilding & Dry Dock Company and the Union Iron Works, the three largest ship-building firms in the country, stating their satisfactory experience with these valves. Among the remaining illustrations are a number from locomotive work, both pop and relief valves, the company having been manufacturing these valves since 1866. Among the valves for locomotivge use is the Blackall relief valve for attachment to locomotive dry pipes, anywhere between the throttle and the steam chest, for the relief of pressure due to reversing the engine while moving forward. On page 44 is a list of about 130 railroads using these goods. The pamphlet is standard size; it is well printed and illustrated and serves its purpose well. Copies will be mailed to those who apply to the above address.

"Pressed Steel in Car Construction."—One of the handsomest catalogues that ever came into this office has just been received from the Schoen Pressed Steel Company of Pittsburgh, Pa. It is 9 by 12 inches in size and is beautifully illustrated with half-tone engravings from photographs and drawings made specially for the purpose. The frontispiece is a page engraving of the works of the company at Pittsburgh, which is followed by an interior view of one of the car erecting shops and one of the exhibit of the company at the World's Fair in Chicago. The other engravings show in succession the truck and body bolsters, the pedestal truck complete, the diamond-frame truck, underframing for flat cars, flat car complete, gondola car, a self-clearing hopper car of 100,000 pounds capacity, a steel car of 80,000 pounds capacity for the P. & L. E. R. R., a twin hopper coal car of 110,000 pounds capacity for the P. R. R., a self-clearing 100,000-pound ore car for the L. S. & I. Ry. and two views of a self-clearing coke car for the Frick Coke Company, all of which are in pressed steel. The last engraving in the book is from an instantaneous photograph showing a train of 35 Schoen pressed steel cars in motion, each car containing a load of 108,000 pounds of ore. The text accompanying the engravings presents in concise language the advantages of pressed steel in car construction. The book is sure to be read and prized by those for whose use it was intended, and it forces the conclusion stated at the beginning of the work that "An all-steel car is not a theory, but an accomplished fact."

"Electricity for Machine Driving." Westinghouse Electric & Manufacturing Company, Pittsburg, Pa.

This is a 24-page pamphlet which points out in a brief, concise manner a few of the advantages to be secured by the substitution of electric distribution of power for the common method, involving long lines of shafting and connecting belts. The methods described lead to great reductions of operating expenses, and the pamphlet is recommended to manufacturers and others who have charge of power transmission plants. It is especially commended to those who are operating plants which, starting from one that is small and well arranged, have grown with the increase in business until they are scattered over large areas, making it necessary to divide the power into a large number of uneconomical units. This applies to many railroad shop plants as well as to manufacturing establishments. The pamphlet is illustrated with handsome half-tone engravings upon the left hand-pages, and opposite them the advantages of electric transmission are presented in concise paragraphs. Its attractiveness will draw attention at once, and the pamphlet will be likely to find a place in files for future reference, if not for immediate use. The style of the author is flowery, but the work is well done.

"Baldwin Locomotive Works. Record of Recent Construction." Pamphlet Nos. 6 and 7, July, 1898.

These pamphlets in the series now regularly published by the Baldwin Locomotive Works illustrate a variety of locomotives of standard and narrow gauges, for domestic and foreign roads, and with steam and electricity for motive powers. The dimensions and characteristics of each design are shown, which makes the record a valuable one for reference and for study of the tendencies in locomotive construction from these works. No. 7 is devoted entirely to narrow-gauge engines, the narrowest being 1 ft. 11⅝ in.

The Chicago Pneumatic Tool Company has found the demand for information concerning its pneumatic tools so great as to necessitate what are termed "special editions" in the form of additions to its catalogues. The latest of these are devoted to riveters, hammers and drills, and to wood boring machines, breast drills and painting machines. They are well printed and well illustrated, and show the machines while actually at work.

"Snow Sweepers, Snow Plows, Track Scrapers." The J. G. Brill Co., Philadelphia, have distributed a 16-page illustrated pamphlet dated Aug. 1, 1898, describing their designs of snow

removers for street railways. Preparations for winter are urged, and the fact of the great loss on account of a single day's snow blockade due to lack of efficient equipment of this kind is pointed out. The illustrations and text give the information necessary to order the snow sweepers, snow plows, nose plows for single track, the Littell track scraper and the combination snow plow and construction car. The usefulness of this last mentioned car is increased by its adaptability to construction purposes when not needed in snow service. These builders have made a specialty of this work, and are prepared to furnish equipment that is of great strength and power.

"Routes and Rates for Summer Tours Via New York Central & Hudson River Railroad, Rome, Watertown & Ogdensburg Division."

This is an octavo pamphlet of 228 pages and 150 excellent engravings of noted places and summer resorts. It gives a list of 800 hotels and routes and rates for 600 combination excursion tickets for Niagara Falls, Thousand Island resorts, Saguenay River, White Mountains, Green Mountains, Adirondack Mountains, Halifax, Portland, Old Orchard Beach, and seacoast resorts of Maine, St. John, N. B., St. Andrews, N. B., and the Maritime Provinces. It contains seven excellent maps printed in colors. Those who contemplate visiting these places and those who do not and would like to read about them will do well to send to Mr. Geo. H. Daniels, General Passenger Agent, for a copy, inclosing 10 cents for postage.

EQUIPMENT AND MANUFACTURING NOTES.

Bement, Miles & Co. are building several large machine tools for export. Among them are eight gun lathes, which are to go to England and Russia.

The Richmond Locomotive & Machine Works have just closed a contract with the Plant System for 12 locomotives, and with the Georgia & Alabama for 4 locomotives.

The new coaches for the Chicago Great Western's new fast train have been painted a dark green, which suggests that the road is getting tired of brick red as a color for its passenger equipment.

The Safety Car Heating & Lighting Company has contracted with the New York Central & Hudson River R. R. for Pintsch gas lighting equipment for 250 additional coaches, which will bring the total number of Pintsch light coaches on that road up to 807.

The Westinghouse Machine Company and the Westinghouse Electric & Manufacturing Company have a combination order for a complete steam plant for Santiago, Cuba. It consists of a 100-H. P. Westinghouse engine and generator, with boiler, feed pump and piping complete.

The Russell Snow Plow Company has recently received orders for a Russell Wing Elevator Snow Plow, size No. 2, from each of the following railroads: The Michigan Central, the Intercolonial Railway of Canada and the Flint & Pere Marquette. The plow for this latter road is to be equipped with the Russell air flanger.

The Brooks Locomotive Works completed their 3,000th locomotive July 23 and held a celebration in honor of the event. The engine was another of the immense mastodons for the Great Northern. The works were founded in 1869. The 1,000th locomotive was completed in 1884 and the 2,000th in 1891.

Mr. G. Fred Collins, who, for a number of years has been connected with Valentine & Company, has, in addition to continuing with them, been appointed Eastern representative of the Ewald Iron Company, St. Louis, manufacturers of Tennessee Charcoal Bloom Stay Bolt Iron, with headquarters at 57 Broadway, New York City.

Bement, Miles & Co. inform us that Mr. Charles E. Billin has severed his connection with the concern as representative in Chicago. We understand that Mr. Billin will give his attention to business under his own name, and that the firm of Bement, Miles & Co. should be addressed as before, at 1534 Marquette Building, Chicago.

The Chicago Pneumatic Tool Company, Monadnock Building, Chicago, received orders for 78 pneumatic machines in a single day, July 25. Such an order received during the summer season is gratifying, as an example of the increasing popularity of these tools. Four of these are for the Imperial Chinese Railway, and the distribution among the different devices was as follows: 44 pneumatic hammers, 8 pneumatic holders on, 6 riveting machines, 4 Boyer piston air drills, 12 breast drills for wood boring, 2 air hoists, 2 flue welders.

The Sargent Company's open hearth steel plant has been running for the past two months at its fullest capacity on several large contracts, among which may be mentioned the castings for 10-in. gun carriages for the United States Government. The company has been very successful in this class of work, readily meeting the physical tests prescribed by the Government, as well as the prompt delivery which is usually demanded. The good record that they have been making is taken as an indication that they will obtain their full quota of this class of work in the awarding of future contracts.

Baltimore & Ohio engine No. 99, which has just been laid aside at Grafton, W. Va., and will be consigned to the scrap pile, has quite a history. It is one of the Ross Winans camel engines and was built in 1851. There are only four of this class now remaining. During the late war this engine was one of several captured at Martinsburg by the Confederates, and hauled across the country by pike to Staunton, Va., under direction of Col. Thomas R. Sharp. President John W. Garrett, after the war was over, hunted up Col. Sharp and appointed him Master of Transportation, in recognition of the ability displayed in that unparalleled achievement.

Within the past 60 days the receivers of the Baltimore & Ohio Railroad have ordered nearly 6,000 new freight cars, of which the Pullman Company is building 1,000 box and 1,000 drop-end gondolas; the Michigan Peninsular 3,000 box cars, and the South Baltimore Car Works 200 box cars, 500 hopper coal cars and 15 four wheel cabooses, making a total of 22,735 freight cars ordered in less than two years. These cars are all of modern construction, are fully equipped with air brakes and automatic couplers and average 60,000 pounds capacity. It is estimated that fully 85 per cent. of the B. & O. freight cars have air brakes and automatic couplers in accordance with the Interstate Commerce Law.

American street cars are used in Manila, and when Admiral Dewey and General Merritt and their men have occasion to ride in that city they will feel "at home." The entire equipment of the "Tranvias de Filipinas" was furnished by Messrs. J. G. Brill Co. of Philadelphia. These cars number about 25, and seat 20 passengers. They weigh less than 2,700 pounds each, which is very light considering their carrying capacity. They are hauled by horses not much larger than Newfoundland dogs. The gage of the road is 3 feet 6 inches, the width of the cars being 5 feet 6 inches and the length 17 feet 6 inches. The closed cars have 2¼-inch steel axles, 2⅛-inch journals.

Messrs. Neilson, Reid & Company of the Hyde Park Locomotive Works, Glasgow, report to "The Railway World" that they have on hand a large amount of work for India, aggregating 137 locomotives. These include 90 passenger engines for the East India Railway, 34 for the Nizam State Railway, 10 for the Indian State Railway and 2 for the Calcutta Port Commissioners. Messrs. Neilson, Reid & Company have hitherto had facilities for the production of about 400 locomotives per annum, but we understand that the works are to be greatly enlarged and that the capacity will be nearly doubled. It is satisfactory to note this evidence of enterprise on the part of one of our best-known locomotive makers. Competition from American manufacturers is constantly becoming keener, and during the past year British builders have had several warnings as to what may be expected in the near future if some special efforts are not made to retain the Eastern trade. Quite recently orders for 77 locomotives for China and 17 for Russia were given to American builders, one of the reasons being that quicker delivery could be obtained from them than from British builders.

The fact that the gross earnings of the Baltimore & Ohio Railroad from the operations of the road for the fiscal year ending June 30, 1898, reached the sum of $27,642,432, an increase of $2,060,310 over the similar period of 1897, has created considerable favorable comment in financial circles. The receivers, after they were appointed and had examined the situation carefully, were confident that if their policy was carried out the earnings of the railroad would be very greatly augmented, and as is well known, they began a series of improvements that, while not yet completed, have progressed sufficiently to demonstrate beyond question that the Baltimore & Ohio Railroad has an earning capacity that will place it in the ranks of the profitable railroads in the country in a few years. The two million dollars' increase in gross was made only with an increase of $281,391 in expenses, giving a net increase of $1,778,919, the approximate net earnings from the roads alone for the year being $7,348,947, over $800,000 in excess of what the fixed charges will be under the plan of reorganization. In addition to these earnings there is a miscellaneous net income from various sources of about $900,000.

OUR DIRECTORY

OF OFFICIAL CHANGES IN AUGUST.

Atchison, Topeka & Santa Fe.—The position of Division Master Mecnanic at Topeka, formerly held by Mr. George W. Smith, now Superintendent of Machinery of the Santa Fe Pacific, has been abolished.

Atlantic Coast Line.—Mr. G. G. Gadsden of Charleston, S. C., has been elected President.

Cornwall.—Mr. A. G. Machesney has been appointed Master Mechanic, with headquarters at Cornwall, Pa. He succeeds Mr. C. J. Herman.

Central of New Jersey.—Mr. William L. Hoffecker has resigned as Division Master Mechanic at Elizabethport, N. J.

Chicago & Northwestern.—Mr. M. L. Sykes is Vice-President and Secretary.

Colorado & Northwestern.—At the annual meeting of stockholders held July 19 at Boulder, Colo., Mr. W. C. Culbertson, Girard, Pa., was elected President, vice E. C. Thompson, Meadville, Pa.

Chesapeake & Ohio.—It has been decided to discontinue the office of Chief Engineer, held by H. Frasier, who resigned recently. The duties will be performed by Engineers Maintenance of Way on each of the grand divisions.

Chicago, Fort Madison & Des Moines.—Mr. E. F. Potter, Vice-President and General Manager, was on July 27 appointed Receiver.

Chicago, Rock Island & Pacific.—Mr. A. L. Studer has been appointed Master Mechanic of the Illinois Division.

Chicago & Erie.—Mr. William Kells has been appointed Master Mechanic, with headquarters at Huntington, Ind., in place of Mr. J. Hawthorne, resigned.

Chicago Great Western.—Mr. A. M. Holcomb has been appointed Assistant Chief Engineer, with headquarters at St. Paul, Minn., in place of Mr. H. A. Stahl, resigned.

Delaware & Hudson Canal Co.—Mr. C. E. Rettew, Master Mechanic of the Pennsylvania Division, has resigned. He is succeeded by Mr. W. R. Johnson, heretofore Foreman of the Locomotive shops at Carbondale, Pa. Mr. Rettew succeeded Mr. S. H. Dotterer as Master Mechanic twelve years ago.

Erie & Central.—Mr. Charles O. Scull has been chosen President. He was formerly General Passenger Agent of the Baltimore & Ohio.

Erie.—Mr. Frank Johnson has been appointed Master Mechanic of the Mahoning Division, with headquarters at Youngstown, Ohio.

Fulton County Narrow Gauge.—Mr. J. D. Thayer, Vice-President and Secretary of this company, died on June 21, 1898, at Burlington, Ia. It is also announced that on June 24, 1898, Mr. J. D. Temple, late Auditor of this company, died at Des Moines, Ia.

Grand Trunk.—Mr. John T. Gill has been appointed Air Brake Instructor, with headquarters at Montreal, Can.

Georgia Southern & Florida.—Mr. O. M. Grady, formerly Roadmaster, has been appointed General Superintendent, succeeding the late Jeff. Lane, with headquarters at Macon, Ga. R. D. Grey, formerly Chief Clerk to Mr. Lane, has been appointed Purchasing Agent, the duties of which office were formerly discharged by Mr. Lane.

Georgia Pine.—Mr. R. G. Stone, General Freight and Passenger Agent of the Macon & Birmingham, has been appointed General Manager of this road. He succeeds Mr. R. B. Coleman, with headquarters at Bainbridge, Ga.

Hannibal & St. Joseph.—Mr. W. W. Lowell has been appointed Division Master Mechanic, with headquarters at Brookfield, Mo.

Indiana, Illinois & Iowa.—Mr. F. C. Raff has been appointed General Superintendent. He was formerly Superintendent.

Interoceanic.—Mr. William Rees has been appointed General Master Mechanic, with headquarters at Juebla, Mex.

Kinderhook & Hudson.—Mr. James Purcell has been elected President.

Louisiana & Northwest.—Mr. F. O. Emerson has been appointed Master Mechanic, with headquarters at Gibsland, La.

Lehigh Valley.—Mr. J. Hawthorne has been appointed Master Mechanic of the Pennsylvania & New York Division, with headquarters at Sayre, Pa., vice Mr. J. N. Weaver, resigned.

Michigan Central.—The title of Mr. H. B. Ledyard, President and General Manager, has been changed to President; the title of General Manager having been dropped.

Mobile & Birmingham.—Mr. T. E. Hartwell, formerly General Foreman, has been appointed Master Mechanic, succeeding J. J. Thomas, Jr., who resigned to accept the position of Master Mechanic of the Mobile & Ohio at Tuscaloosa, Ala.

Maine Central.—Mr. Charles D. Barrows has been appointed Purchasing Agent. He succeeds Mr. Arthur S. Bosworth.

Michoacan & Pacific.—Mr. E. W. Knapp has been appointed Master Mechanic, with headquarters at Zitacuaro, Mex., vice Mr. W. H. Rice, resigned.

New York, New Haven & Hartford.—Mr. W. E. Chamberlain has been appointed General Manager. He was formerly General Superintendent of the Old Colony System.

Northern Pacific.—The following changes have been made on this road: Mr. William Clarkson, Master Mechanic at Missoula, Mont., has been transferred to Livingston, Mont., vice Mr. Brown; Mr. E. P. Barnes, General Foreman at Brainerd, Minn., succeeds Mr. Clarkson, and Mr. Harry Lyddon, General Foreman at Mandan, N. D., succeeds Mr. Barnes. Mr. W. L. Darling has been appointed Assistant Chief Engineer, with headquarters at St. Paul. Minn. Mr. E. M. Herr, Superintendent Motive Power, has resigned, and is succeeded by Mr. William Forsyth, formerly Mechanical Engineer of the C., B. & Q. R. R.

Port Jervis, Monticello & New York.—Mr. Addison B. Colvin has been chosen President, to succeed Mr. Thomas J. Waller, resigned.

South Atlantic & Ohio.—Mr. John M. King has been appointed Master Mechanic of the shops at Bristol, Va., and Tenn., succeeding Mr. E. M. Roberts, resigned.

San Diego, Pacific Beach & La Jolla.—Mr. S. C. Boutelle has resigned as Master Mechanic, on account of ill health.

Spokane Falls & Northern.—Mr. C. Shields has been elected Vice-President, with headquarters at Seattle, Wash.

Staten Island Rapid Transit.—Mr. J. Van Smith was appointed Receiver by the Supreme Court of the State of New York on July 14. Notice was given by President J. F. Emmons that all officers, agents, servants and employees were discharged July 14.

Toledo, Bowling Green & Vermont.—Mr. F. J. Hoag has been elected President.

Toledo, St. Louis & Kansas City.—Mr. T. C. Morris has been appointed Chief Engineer, with headquarters at Toledo.

Terre Haute & Indianapolis.—Mr. William Wright, formerly Chief Draughtsman of the Pennsylvania at Altoona, Pa., has been appointed Master Mechanic, with headquarters at Terre Haute, Ind.

Toluca & Tenango.—Mr. I. O. Nicholas, formerly Foreman at Toluca, Mex., of the Mexican Central, has been appointed Master Mechanic, succeeding Mr. E. W. Knapp. resigned.

Wisconsin Central Lines.—Mr. Angus Brown has been appointed Superintendent of Motive Power and Cars.